MEKELLE UNIVERSITY

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Effect of Access to Potable Water and Sanitation on Rural Health

The case of Tigray National Regional State

By

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A Thesis

Submitted in Partial Fulfillment of the Requirement for the Degree of Master of Science in Economics

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Declaration

I,BerihaTsegay, hereby declare that the thesis work entitled “Effect of Access to Potable water and Sanitation on rural Health in Tigray Region” submitted by me in partial fulfillment of the requirement for the award of the degree of Master of Science in Economics to the college of Business and Economics, MekelleUniversity, through the Department of Economics,isoriginal work carried out by myself. The matter embodied in this thesis work has not been submitted earlier for award of any degree or diploma to the best of my knowledge and belief.

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Certification

This is to certify that this thesis entitled “Effect of Access to potable water and Sanitation on rural Health in Tigray Region” is an authentic work of BerihaTsegayId.No.CBE/PE239/03 who carried out the research under my guidance, Certified further, to the best of my knowledge the work reported here in does not form part of any project or thesis on the basis of which a degree or award was conferred on an earlier occasion on this or any candidate.

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Abstract

This thesis examines the effect of access to potable water and sanitation on diarrhea morbidity and pneumonia incidence reduction. Probit model is used to analyze the effect of water and sanitation on diarrhea morbidity and pneumonia incidence reduction in this study, using 199 household heads using data collected in 2010/2011 by REST from three weredas of TigrayRegion. Results show that access to potable water and sanitation infrastructure lowers diarrhea morbidity and pneumonia incidence. Hygiene education and sanitation practices reduce diarrhea morbidity by 54 % that there is a positive relationship between having access to potable water and sanitation facilities and a decrease in the likelihood of households being exposed to diarrhea morbidity. Latrine with supper structure in households' compound reduces pneumonia incidence by 22% and it is statistically significant at 5% with positive relationship with pneumonia incidence reduction.

Keywords: *Water access, sanitation, Morbidity, Pneumonia, Welfare Probit, Tigray*

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Acronyms

ARI	Acute Respiratory infection
BPMP	Back ground paper millennium project
CC	Contingency coefficient
CSA	Central Statistical Agency
DHS	Demographic and Health Survey
EU	European Union
GAPP	Global Action Plan for Prevention and control of pneumonia
GTP	Growth and transformation plan
HEW	Health Extension Works
IBNET	International bench marking Network for water and sanitation
IRHA	International Rain water harvesting association
JMP	Joint Monitoring Programme
LOS	Level of Service
MDG	Millennium Development Goals
MEAT	Ministry of Environmental Affairs and Tourism
ME	Ministry of Education
MH	Ministry of Health
MPACD	Ministry of Provincial Affairs and Constitutional Development
NGO	Non-Governmental Organizations
OLS	Ordinary Least Square
OWRMB	Oromia Water Resource Management Bureau
PASDEP	Plan for Accelerated sustained Development and to End Poverty
RES	Relief for society of Tigray
UNDP	United Nation Development Program
UN-	United Nations Human Settlements Program
VIP	Ventilated improved pit
UNICEF	United Nations Children's Emergency Fund
WHO	World Health Organization
WRI	World resource institute
WSS	Water supply and Sanitation
TDA	Tigray Development Association
TRPFB	Tigray Region Plan and Finance Bureau
VIF	Variance Inflation Factor

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Chapter One

Introduction

1.1. Background of the study

In many developed and developing countries provision of quality urban and rural infrastructure system has become a major concern. Contrary to this, less attention has been given to the quality aspect of water supply. The low quality of infrastructure such as water supply and sanitation may be detrimental to the environment leading unhealthy living conditions. The performance of one infrastructure may affect the other due to their interconnection for instance water supply and sanitation are highly interrelated. Hence, understanding this integration and interrelation provide a better consideration on the importance of providing quality infrastructure (Salendu, 2010).

According to the United Nations Development Program (UNDP, 2006), nearly one-sixth of the world's population obtains drinking water from unimproved sources, and in many developing areas, progress in expanding clean water coverage is modest. In Sub-Saharan Africa, for instance, the proportion of the population that depends on unimproved sources has declined only slightly, from 52 percent in 1990 to 44 percent in 2004 (UNDP, 2006). The unavailability of safe drinking water in most rural locations is one of the main causes of diarrhea among children under the age of five (CSA, 2006). The negative health impact of contaminated water is exacerbated because more than 90 percent of households consume this water untreated (ibid). Previous empirical studies such as the one byEsrey (1996) also show that access to improved water is an important contributor to improved child health and mortality reduction. In Ethiopia, the problem of drinking water supply is further compounded by physical distance. According to Central statistics Agency (CSA, 2006) about 52 percent of the population traveled half an hour or more to collect water every day.

Half a century efforts of WHO- UNICEF and other international organizations that exerted to improve water and sanitation conditions around the world have contributed to global awareness, to the establishment of international programs and the strengthening of national institutions.

In the 1990s this afforded improved water supply for more than 800 million people and sanitation for around 750 million people (WHO/UNICEF, 2000).

Despite the exhaustive efforts of many institutions at the national and international levels, around 1.3 billion people in the developing world lack access to adequate quantity of clean water and approximately three billion people are without adequate means of waste disposal. (Bosch et al, 2001). It is estimated that 10,000 people die every day from water and sanitation related diseases while thousands suffer from a range of water and sanitation related illnesses. The effect of inadequate water and sanitation services falls primarily on the poor. The poor who are badly served by the formal sector make their own, often inadequate, arrangements to meet basic survival needs. Many fetch water from long distances or end up paying high prices to water dealers for very small quantity of water (Bosch et al, 2001).According to Brocklehurst (2004), in the last 50 years, the world's urban population has increased fourfold, and now around 50% of the world's population lives in urban centers. While urban populations grew rapidly, expansion of water supply and sanitation services did not. Spending on water supply and sanitation has not kept pace with growth, and there are dramatic differences in infrastructure expenditure between cities in low and high income countries. As a result, it is estimated that between 30% and 60% of the urban population in most nations is not being adequately served. By 2025, urbanization in Africa will have progressed from about 32 to 50 % with the urban population increasing from 300 million to 700 million (WUP, 2003).

Access to safe water and sanitary means of waste disposal are universal needs and indeed basic human rights. Besides, they are essential elements of human development and poverty alleviation and constitute necessary component of primary health care. Hence, provision of adequate sanitation services, safe water supply, and hygiene education represents an effective health intervention that reduces the mortality caused by diarrheal disease by an average of 65% and the related morbidity by 26%.(WHO-UNICEF 2000). Contrary to this, inadequate sanitation, poor hygiene and unclean water result not only in more sickness and death, but also in higher health costs, lower productivity, lower school enrollment and retention rates of girls and perhaps most importantly the denial of the rights of people to live with dignity.(ibid).

The MDGs pose particular emphasis on the importance of improved coverage of water and sanitation supply and have a global target to reduce by half the proportion of people without

sustainable access to safe drinking water and basic sanitation by the year 2015. Achieving the targets will involve various challenges and pose a continuous struggle for many countries in Africa. As a result of rapid growth in urbanization with increased rural urban migration and informal settlements, population growth, and poverty, African governments will need to be able to provide access to safe water to 210 million and sanitation to 211 million additional urban residents over the next 15 years. It is also estimated that almost 300 million Africans will be living in shantytowns and informal settlements by the year 2020. This implies that investments in water supply and sanitation would necessitate injections that if governments are to maintain current levels of water supply and sanitation provision, under the projected growth scenario, access to these services should increase by 10 million a year for a 10-year period (UNESCO,2005).

The availability of water sources throughout the world is becoming depleted by the rate at which populations are increasing, especially in developing countries. This has brought into focus the urgent need for planned action to manage water resources effectively for sustainable development (Khatri and Vairavamoorthy, 2007).

1.2. Statement of the Problem

Ethiopia ranks among the lowest countries in the world in levels of safe water and sanitation coverage. 66% of Ethiopia's 83 million citizens do not have access to an improved water supply and 79% lack access to basic sanitation. The majority of Ethiopia's citizens live in rural areas where rates of coverage are even worse. Among rural Ethiopians, only 34% have access to an improved water supply.(Water access in Ethiopia 2013).

Access to potable water substantially improved during the PASDEP period (2005/06 - 2009/10), increasing from 36% to 68.5% at the national level. In many local communities, however, access to potable water is still a great challenge, and the southern and eastern parts of Tigray are no exception. Tigray is a Region with a complex topographical and geological backdrop, which has made it difficult to ensure safe and sustainable water resources. The water supply ratio in Tigray was only 33.3% in 2005/2006. The Region’s access to potable water improved to 54% in 2009/2010 but was still lower than the national average. Under the GTP, it is planned to raise water supply coverage from 68.5% to 98.5% at the national level in five years. In its first year of implementation, potable water supply coverage at the national level improved from 68.5% to

73.5%. Improvement in coverage was also impressive in Tigray where it increased from 54% to 67% during the same period. However, the task of water supply still requires continued efforts by the Ethiopian Government and its development partners. http://www.et.emb .japan.go.jp/oda-ehtm.

Getachew (2002) stated that, water supply and sanitation situation in Ethiopia is very poor, as most of the population does not have access to safe and adequate water supply and sanitation facilities. As a result three-fourth of the health problems in Ethiopia is due to communicable diseases caused by unsafe or inadequate water supply and improper waste management particularly excreta (faeces and urine). Diarrheal diseases caused by improper management of water and sanitation are among the major causes of infant and child morbidity and mortality. To the contrary, water and sanitation programs have a direct bearing on the prevalence of diarrheal diseases in the population. The combination of safe water supply, sanitation facilities and hygienic practices demonstrated a high potential in contributing to a remarkable decrease in the prevalence of a child and maternal morbidity and mortality

The estimated water service level of Ethiopia in terms of coverage, quantity, quality, and reliability is among the lowest in the world. Sanitation facilities are also in worst condition. Due to unreliability of safe and sufficient water supply and adequate sanitation facilities the estimated service level could be in much less situation. These combine effect of the poor water supply and sanitation facilities in the country have high effect on the economic development of the country and the living condition of the towns' communities (OWRMB, 2009).

Increased access to clean water is an integral part of Ethiopia's economic development and poverty reduction policy. Official figures (MOFED 2008) indicate increased clean water coverage in the country. Despite the increased support provided to the sector, there are millions of people still depending on unsafe drinking water sources, especially in the rural areas of the country. In this regard, a survey of (WSP 2004 cited in UNDP 2006) indicates that improved water infrastructure in rural Ethiopia is not functioning properly due to maintenance problems, suggesting that uncertainty regarding water availability remains a challenge for the local population.

It is known that the development of infrastructure plays a great role in realizing economic development. Similarly, infrastructure has a tremendous contribution to attract and encourage private investments. Thus, there has been unreserved effort made by the regional and federal governments, and non-governmental organizations to benefit all woredas, cities and kebelles from infrastructure services economically and socially. Based on this, in the years before 2009 around 1671 km main roads (of which 488 km is asphalt), 1357 km rural road and totally 3028 km road was constructed by the regional government, federal government and other donor organizations.(Tigray Region Plan and Finance Bureau 2010). On the other hand, an encouraging achievement has been registered in the expansion of telecommunications. Hence, 226,751 customers/ clients are able to use mobile phone and the mobile phone network covers 64% of the land. Similarly, over 153,374 customers are beneficiaries of the land line telephone and the coverage for wireless telephone is 90% .An electrification program was also formulated and has been implemented both in the urban and rural areas throughout the nation. In relation to this program, a great endeavor has been undertaking to expand the electric power both in the rural and in the urban areas of Tigray region. As a result, 197 towns and rural centers are already benefited from the electrification program. In general, 121953 households have already got electric consumption counter and this means that the electrification covers 12 % of the total households.(ibid).

When we see the health problem in Tigray region, evidences show that most of the health problems are caused due to lack of clean water. Thus, so as to solve this problem, the government has been engaged in upgrading the clean water supply both in the urban and in the rural areas and eventually the coverage of potable water in urban areas has grown from 50% to 72% and in the rural areas it has increased from 41% to 60%. To expand the coverage of health services to all parts of the region, an integrated effort has been made by the government, the society and donor organizations and thus an encouraging achievement has been registered. (Tigray Region Plan and Finance Bureau report, 2010).

As we have seen above there has been unreserved effort made by the regional and federal governments, and non-governmental organizations to benefit all woredas, cities and kebelles from infrastructure services economically and socially. For instance, to solve the health problems that cause due to lack of clean water the government has been engaged in upgrading the clean water

supply both in the urban and in the rural areas and eventually the coverage of potable water in urban areas and rural areas has increased.

In this case the intention of the researcher is to assess the effect ofaccessto potable water and sanitation on diarrhea morbidity and pneumonia incidence reduction.

1.3. Objective of the Study

1.3.1. General objective

The main objective of this study is to assess the effect of access to safe water and sanitation on diarrhea morbidity and pneumonia incidence reduction at household level in Tigrai Region.

1.3.2. Specific Objectives

• To assess levels access to safe drinking water and sanitation

•To assess the major problems related to shortage of potable water

• To assess the significant of access to water and sanitation to house hold health.

• To assess the effect of access to water and sanitation on diarrhea morbidity and pneumonia incidence reduction.

1.4. Research questions

What does the water and sanitation situation look like in the study area?

What are the major problems related to shortage of potable water?

Dose access to potable water and sanitation reduces children and adult diarrhea morbidity?

Is diarrhea and pneumonia morbidity lower for households withaccess to water and sanitation package than households without access to the same?

1.5. Hypothesis of the study

H1: Water and sanitation has positive effect on household diarrhea and pneumonia reduction

H2: Diarrhea and pneumonia morbidity is lower for household who utlize water and sanitation package than households without water sanitation package

1.6. Significance of the study

An in depth study of effect of access to potable water and sanitation on rural healthhelp to improve households' attitude towards sanitation and hygiene and education practices. Research on issues concerning effect of access to potable water and sanitation on rural welfare is crucial for formulating programs for the reduction of diarrhea morbidity and pneumonia incidence. The study gives a clue for policy makers and planners towards major bottlenecks of rural welfare.The provision of clean drinking water and sanitation are the main problems in whole world predominantly in poor countries like Ethiopia. Hence, the study result shows that the existing water supply and sanitation situation of the urban and ruralinhabitants by investigating the sources of water, levels of sanitation services, causes of water and sanitation inaccessibility and their effects on the livelihood of the people and environment. It also provides insight to NGOs, community based organizations and other stakeholders who are concerned with water supply and sanitation problems. The study result might initiate other researchers to conduct different research works from different perspectives.

1.7. Scope and limitation of the study.

The study area is mainly confined to only three weredas in Tigray Regional State namely, Tanqua-abergele,Adwa and Hintalo-wejerat.Moreover,inorder to evaluate the gathered data effectivelyand maintain the scope withina stipulated time and financial limitthe study deals with a limited number of households and focused on effect of potable water and sanitation on rural welfare (health).

Concerning to documents and secondary data in the visited office, RST there were no adequate documents, which were relevant to this study. Missing value of baseline data for most variables (outcome and explanatory variables)were very difficult to get the necessary information and this influenced the study to some extent to review the literatures. Shortage of time and finance were also major challenges to accomplish this paper.

1.8 .Organization of the paper

This paper is organized in to five consecutive chapters. Chapter one is introduction and covers background of the study, statement of the problem, objectives of the study, research questions, and working hypothesis of study, organization of the paper and limitation of the study. Information on the previous works and empirical findings will be properly sifted out and entertained in chapter two. The third chapter deals with data source and research methodology where the data source, data type, and data use, area of study, model specifications, and variables are presented. Chapter four gives the analysis and interpretation of descriptive and econometric analysis. Finally conclusions drawn from the analysis of the data and policy implications as well as recommendation are covered in chapter five.

Chapter Two

Literature Review

2. 1.Water Supply/Access and Its Implication

2.1.1. Concepts andDefinitions

The Joint monitoring programme for Water Supply and Sanitation set up by the World Health Organization (WHO) and United Nations Children's Fund (UNICEF) defined safe drinking water as "water with microbial, chemical and physical characteristics that meets WHO guidelines or national standards on drinking water quality."The guide lines include an assessment of the health risks presented by the various microbial, chemical, radiological and physical constituents that may be present in drinking-water.

Water is a fundamental Human Right

B.arbaraGemmill (2008) stipulated that the fact that water is not treated as a basic human right remains a major impediment to equitable access, distribution and use of water. Water is a fundamental life-support, which cannot be treated as a commercial commodity with supply and demand manipulated to increase its value and with alternatives that can be substituted. Water is a public trust issue and which must not be privatized. New developments in international human rights law provide a viable framework to measure and improve government performance. The United Nations Committee on Economic, Social and Cultural Rights has elaborated specific rights, roles and responsibilities at different levels and it provides an enforceable framework for recognizing water as a human right. And it states that Governments must assert their primary responsibility for providing and regulating water and sanitation services.

2.1.2 Importance ofWater

Several studies have documented the significant positive effect of water on reducing child diarrhea (Esrey et al., 1991; Fewtrell et al., 2005; and Waddington et al., 2009). Moreover,

improved water has been shown to lower the health risks related to bilharzia, trachoma, intestinal helminthes and other water related diseases. In addition, improved water is likely to reduce the burden of disease related to other major health issues by reducing the average stress level for the immune system, and thus strengthening the resistance to responde to new infections.

Chekley et al (2004) assess the impact of water and sanitation on children nutritional status in a cohort of Peruvian children. The findings show that nutritional status is related to the quality of water and sanitation interventions and highlights the need to improve sanitation in developing countries. More reliable water sources diminish the risk of contaminated water, decrease diarrhoeal incidence, and improve growth in children.

Jalan and Ravallion (2001) constructed a behavioral model for children, where health status depends on access to piped water, parental spending on private inputs to child health, and a vector of personal and environment characteristics. The authors use Propensity-score matching methods to estimate the causal effects of piped water on child health in a cross-sectional sample. Among the findings are a significantly lower prevalence of the disease for children living in households with piped water compared to a comparison group of households matched on the basis of their propensity scores.

Most of the adverse effect of water-related disease is borne by poor households, especially those without reliable access to basic services.

2.1.3 The Effect of Shortage of Water Supply/Access on Societal Welfare

Water scarcity or lack of safe drinking water is one of the world's leading problems affecting more than 1.1 billion people globally, meaning that one in every six people lacks access to safe drinking water.(Blue planet network.org.2012.) As of 2006, one third of all nations suffered from clean water scarcity, but Sub-Saharan Africa had the largest number of water-stressed countries than other place on the globe. In Africa, the struggle for access to clean drinking water is one of today's most obvious examples of how water scarcity leads to the stalling and reversal of human progress. While each individual living in the United States uses on average 100 to 175 gallons of water per day in the home, the average African family uses only 5 gallons of water per day. (http://enwikipedia org/wiki/water scarcity in Africa .This vast disparity of clean water

availability and consumption is reflected in a number of different developmental aspects. These consequences include the effects on health, opportunities for women, children's education, agricultural practices, productivity, and development.(http://enWikipedia org/wiki/water scarcity in Africa, 2012). The most immediately apparent impact of water scarcity in Africa is on the continent's health. With a complete lack of water, humans can on average only live up to 3 to 5 days. ((http://enWikipedia org/wiki/water scarcity in Africa, 2012).This often forces those living in water deprived regions to turn to unsafe water resources, which then contributes to the spread of waterborne diseases including malaria, typhoid fever, cholera, diarrhea, and can lead to diseases such as trachoma, and typhus (IBNET2012). Additionally, water scarcity causes many people to store water in their households, which increases the risk of household water contamination and incidents of malaria and dengue fever spread by mosquitos. These waterborne diseases are not usually found in developed countries because of sophisticated water treatment systems that filter and chlorinate water, but natural, untreated water sources often contain tiny disease-carrying worms and bacteria. (International water management institute, 2007). Although many of these waterborne sicknesses are treatable and preventable, they are nonetheless one of the leading causes of disease and death in the world. Globally, 2.2 million people die every year from diarrhea-related disease, and at any given time fifty percent of all hospital beds in the world are occupied by patients suffering from water-related diseases. (JMP, 2010). Infants and children are especially susceptible to these diseases because of their inexperienced immune systems, (International water management institute 2007).

When infected with these waterborne diseases, those living in African communities suffering from water scarcity cannot contribute to the community’s productivity and development because of a simple lack of strength. Additionally, economic resources are drained by the cost of medicine to treat waterborne diseases, which takes away from resources that might have been used for food or school fees.(International water management institute,2007). This also takes a toll on the governmental funds. The Water Supply and Sanitation Collaborative Council (WSSCC) estimates that in Sub-Saharan Africa, treatment of diarrhea due to water contamination consumes 12 percent of the country’s health budget. With better water conditions, the burden on health care would be less substantial and a healthier workforce would stimulate economic growth and pull many people out of poverty (World resources institute 2010).

2.2. Women,Childrenand Education

African women are disproportionally burdened by scarcity of clean drinking water. In most African societies, women are seen as the collectors, managers, and guardians of water, especially within the domestic sphere that includes household chores, cooking, washing, and child rearing.(Wikipedia, 2009) Because of these traditional gender labor roles, women are forced to spend around sixty percent of each day collecting water, which translates to approximately 200 million collective work hours by women globally per day.(UN Habitat. 2010). For African women, this often means carrying the typical jerrycan that can weigh over 40 pounds when full (Joint Monitoring program for water supply and sanitation 2010). As a result of this, many women are unable to hold professional employment. Additionally, this prevents many young girls from attending school and receiving an education. They are expected to not only aid their mothers in water retrieval, but to also help with the demands of household chores that are made more time-intensive because of a lack of readily available water. Furthermore, a lack of clean water means the absence of sanitary facilities and latrines in schools, and so once puberty hits, this has the largest impact on female children. In terms of lost educational opportunity, if adequate investment were made in drinking water and sanitation, it is estimated that it would result in 272 million more school attendance days per year. (UN Habitat, 2010). This lost number of potential school days and education results in the hindrance of the next generation's African females from breaking out of the cycle of unequal opportunity for gainful employment. Because of this, available clean water for women and children translates to Africans with potential for education, prosperity, power, literacy, hygiene, security, and equality (UN Habitat, 2010).

2.3. Productivity andDevelopment

Poverty is directly related to the accessibility of clean drinking water- without it, the chance of breaking out of the poverty trap is extremely slight. The social and economic consequences of a lack of clean water penetrate into realms of education, opportunities for gainful employment, physical strength and from health, agricultural and industrial development, and thus the overall productive potential of a community, nation, and/or region. Because of this, the UN estimates that Sub-Saharan Africa alone loses 40 billion potential work hours per year collecting water (WHO. 2007). Because of this, the United Nations Development Programme estimated that in Africa,

every dollar spent on water and sanitation generates a nine-fold return in saved time, increased productivity and reduced health cost. (Wikipedia, 2012).

According to Murray and Lopez (1996) the leading cause of under-five mortality in Kenya is pneumonia, malaria and diarrheal disease, which are estimated to have been responsible for some 60 percent of disease burden in the region. Kenya experienced dramatically fall in child mortality in the late 1940's and early 1960's. Until around 1980, the under -five mortality rate fell at an annual rate of about 4 percent per annum due to the increased use of contraceptives.(African population studies 2006). This rate of decline slowed in the early 1980s to about 2 per cent per annum. Data from the 1998 Kenya Demographic and Health Survey (NCPD, 1989) show that, far from declining, the under-five mortality rate increased by 25 percent from the late 1980s to the mid-1990s. Hundreds of millions of others, both children and adults, suffer ill health and disability that undermine their quality of life and hopes for the future (ibid). These most serious environmental health facing the world's population today, stem mostly from traditional problems such as a lack of clean water, sanitation, adequate housing, and other insect and animal disease vectors. Poverty also influences health because it largely determines an individual's environmental risks, as well as access to resources to deal with those risks. Throughout the developing world, the greatest environmental health threats tend to be those closest to home. More than one billion people in developing countries live without adequate shelter. A further 1.4 billion lack access to safe water, while another 2.9 billion people have no access to adequate sanitation (WDI, 2004), all of which are essential for good hygiene.

Moulton (2004),indicates that infant mortality rates in Kenya are still very high compared to other countries and have increased by 30 percent between 1989 and 2003. Reducing child mortality is the fourth Millennium Development Goal, whose target is to reduce the under-five mortality rate by two-thirds between 1990 and 2015. Despite numerous interventions and action plans, very little evidence exists on why the infant and child mortality rates are increasing in Kenya. Moulton LH. (2004) stipulated that, if Kenya is committed to achieving the MDG on child mortality, it is prudent to understand clearly the factors that are contributing to the high levels of mortality. The study therefore explores the household's environmental and socio-economic characteristics and their effect on child and infant mortality in Kenya.

A large number of studies have investigated the empact of water supply and sanitation interventions on child health worldwide (Jalan and Ravallion 2003).

A comprehensive review conducted by Waddington et al. (2009) on the impact of water, hygiene, and sanitation interventions on diarrhea morbidity highlighted the fact that water quality is more important than water supply in reducing diarrhea. Additionally, the authors found sanitation facilities to be as effective as hygiene in reducing diarrhea morbidity.

According to the United Nations MDG report (2011), progress has been good on increasing access to clean drinking water. The global target is likely to be outshined, although rural areas are lagging behind and more than one in ten people may still not have full access to safe drinking water by the 2015 deadline. While some regions, such as east and south-east Asia, have already gone beyond the target, progress varies widely. Sub-Saharan Africa remains far behind: Despite having almost doubled the number of people using an improved water source between 1990 and 2008, coverage was still only 60% in 2008. The 2011 report shows slower worldwide progress with regard to basic sanitation, where the picture is quite bleak. The percentage of the world's population using an adequate toilet rose just 7% from 1990 to 2008, from 54 to 61%. Almost half of the population in developing regions do not have access to sanitary facilities, and an estimated 1.1 billion people practice open defecation, exposing themselves and their communities to major health risks. In sub-Saharan Africa, only 24% of the rural population were using an improved sanitation facility.The Millennium Declaration of 2000 and the subsequent effort to achieve the Millennium Development Goals (MDGs) gave new impetus to long-standing efforts by governments and other development actors to enhance access to water and improve sanitation. The goal was to deal with this central cause of poverty and sickness for millions of people – especially children and women – around the world (Ministry of Foreign Affairsthe Nether lands. 2012).

2.4. Theoretical Frame Works

Theoretical frameworks are often presented as health production functions, which capture the structural relation between health outcomes and the household's behavioral variables, like nutrition, breastfeeding, child spacing, etc. (Schultz, 1984). In the framework of a health

production function, child mortality risks depend on both observed health inputs and unobserved biological endowment or frailty. (Schultz, 1984).

There are a number of different analytical frameworks through which to view the effects of different determinants on childhood mortality.

Demographic research by Mosley and Chen (1984) and by Schultz (1984) made the distinction between variables considered to be exogenous or socioeconomic (i.e. cultural, social, economic, community, and regional factors) and endogenous or biomedical factors (i.e. breastfeeding patterns, hygiene, sanitary measures, and nutrition). The effects of the exogenous variables are considered indirect because they operate through the endogenous biomedical factors. Likewise, the bio-medical factors are called intermediate variables or proximate determinants because they constitute the middle step between the exogenous variables and child mortality (Jain, 1988; Mosley and Chen, 1984; Schultz, 1984; UN, 1985). Mosley and Chen (1984) were among the first to study the intermediate biomedical factors affecting child mortality, labeled 'proximate determinants' They distinguished fourteen proximate determinants and categorized them into four groups: maternal (fertility) factors, environmental sanitation factors, availability of nutrients to the foetus and infant, injuries, and personal illness control factors.(Mutunga,2004).

2.5. Water Supply and Sanitation in Ethiopia

Access to water supply and sanitation in Ethiopia is amongst the lowest in Sub-Saharan Africa and the entire world. (WHO, UNICEF, 2008) While access has increased substantially with funding from external aid, much still remains to be done to achieve the Millennium Development Goal of halving the share of people without access to water and sanitation by 2015, to improve sustainability and to improve service quality. (WHO, UNICEF. 2008).

Some factors hindering the achievement of these goals are the limited capacity of water bureaus in the country's nine regions and insufficient cost recovery for proper operation and maintenance (WHO. 2007).

In 2001, the government adopted a water and sanitation strategy that called for more decentralized decision-making; promoting the involvement of all stakeholders, including the private sector; increasing levels of cost recovery; as well as integrating water supply, sanitation

and hygiene promotion activities (WHO 2010). Moreover Implementation of the policy apparently is uneven (WHO/UNICEF 2010).

In 2005, the government announced highly ambitious targets to increase coverage in its Plan for Accelerated Sustained Development and to End Poverty (PASDEP) for 2010. The investment needed to achieve the goal is about US$300 million per year, compared to actual investments of US$39 million in 2001-2002. In 2010 the government presented the equally ambitious Growth and Transformation Plan (GTP) 2011-2015 that aims at increasing drinking water coverage, based on the government's definition, from 68.5% to 98.5% (MOFED 2010) .While donors have committed substantial funds to the sector, effectively spending the money and to ensure the proper operation and maintenance of infrastructure built with these funds remain a challenge.

Ethiopia has 12 river basins with an annual runoff volume of 122 billion m3 of water and an estimated 2.6 - 6.5 billion m3 of ground water potential. This corresponds to an average of 1,575 m3 of physically available water per person per year, a relatively large volume. However, due to large spatial and temporal variations in rainfall and lack of storage, water is often not available where and when needed. (SeleshiBekele et al.,2007). Only about 3% of water resources are used, of which only about 11% (0.3% of the total) is used for domestic water supply (WRI 2010).

The great majority of the rural community water supply relies on groundwater through shallow wells, deep wells and springs. People who have no access to improved supply usually obtain water from rivers, unprotected springs and hand-dug wells (MekonenLoulseged et al., 2007). According to data from the Joint Monitoring Programme for Water Supply and Sanitation of WHO and UNICEF, which are in turn based on data from various national surveys including the 2005 Ethiopia Demographic and Health Survey (DHS), access to an improved water source and improved sanitation was estimated as follows in 2008:

38% for improved water supply (98% for urban areas and 26% for rural areas), 12% for improved sanitation (29% in urban areas, 8% in rural areas),(JMP.2010).

In 1990 access to improved water supply had been estimated at only 17%, and access to improved sanitation had been estimated at only 4%.(WHO and UNICF. 2010]. There thus has been a significant increase in access for water supply and sanitation, which spans both urban and rural areas. More than 138,000 improved community water points were constructed and rehabilitated

from 2008 to 2010 (World Bank 2011).In communities that lack access to an improved water source, women bear the effect of the burden of collecting water. For example, according to an article by Tina Rosenberg for National Geographic, in the mountain-top village Foro in the Konso special woreda of southwestern Ethiopia women make three to five round trips per day to fetch dirty water from the Koiroriver. Each round trip lasts two to three hours and water is carried in "50-pound jerrycans"(Tina Rosenberg 2010).

2.6. Drinking Water Quality

Since 2006, the European Union (EU) has been supporting UNICEF water, hygiene and sanitation projects countrywide – in 78 woredas (districts) of Ethiopia's nine regions.(UNICEF). As part of an accelerated programme towards achieving Ethiopia's Millennium Development Goals (MDGs) for water and sanitation, the EU has contributed 10.8 million euros, out of the total 21.6 million euro cost of UNICEF's water, sanitation and hygiene programmes targeting 1.4 million people countrywide. Ethiopia's ambition for the MDGs was to extend clean water to 85 per cent of the population.(UNICEF) . In Ethiopia, the under-5 mortality rate is 123 per thousand and nearly half those deaths (46 per cent) are as a result of diarrhoea.(UNICEF,2008).

Drinking water quality in Ethiopia varies. The most comprehensive picture of drinking water quality are the results of a national statistically representative survey of piped water supply, boreholes, protected dug wells and protected springs carried out by the WHO and UNICEF in 2004-2005. It shows that 72% of samples complied with the values for coliform bacteria in the Ethiopian drinking water standard ES 261:2001 and the WHO guidelines for drinking water. In the case of piped water supply by utilities compliance was highest at 88%. Open wells and unprotected springs were not included in the survey. The results of the survey confirm the results of routine monitoring undertaken in the laboratories of the Regional Water Bureaus and the Regional Health Bureaus. The latter results are archived at the Ethiopian Health and Nutrition Research Institute. Interaction and exchange of information between regional health bureaus and regional water bureaus is poor.(WHO/UNICEF(2010). According to World Health Organization (2007) diarrheal diseases has been critical health problem especially for under the age of five years children causing 800,000 children deaths per year. Moreover, it is more serious than HIV and malaria. One of the key causes contributing to the frequency and burden of diarrheal disease

is due to lack of water in a majority of developing countries (Zwane and Kremer, 2007). To some extent more progress has been made in the water sector, but 21% of the population in developing countries still does not have access to adequate drinking water (UNDP, 2007/2008). The situation is more severe for Sub-Saharan African countries, where 45% of the population lacks safe drinking water supply (UNDP, 2007/2008).

Endemic water shortages created by drought, inequitable geographic and social distribution of supply, population growth, wastage by agriculture and industry, lack of pollution control standards coupled with poor or nonexistent waste water treatment, can addressed under government schemes and its ability to govern resources, that needs strengthening and hand-in-hand with civil society and local communities. Addressing these problems often requires democratic and governance reforms, as was recognized in the Hague Declaration on Water Security. The reality is that the present global market for water supply technology and services is large, undiversified and inequitable. This 400 billion dollar industry is controlled by just a few large multinationals. They are also subsidized; receiving export credits from their governments and sharing in the benefits of development loans to the countries in which they agree to do business, NGO, major group discussion paper on water, sanitation and human settlements, by (BarbaraGemmill, and Samuel Waweru 2008).

2.2. Sanitation

According to Draft white paper issued jointly by several ministries (MWAF el at. 2008) the term sanitation means different things to different people. It could simply refer to the provision of toilets, health education aimed at changing personal attitudes and practices, the disposal of waste water, at household or at municipal level, solid wastes (household refuse, industrial waste), and also include the whole range of environmental issues It is acknowledged that all these issues are inter-related and equally important. There for this paper adopts a broad definition.

According to MOH (2008) sanitation refers to the hygienic principles and practices relating to the safe collection, removal or disposal of human excreta, refuse and waste water, as they impact upon users and the environment. National sanitation task team (2008) also defined adequate

sanitation as about both physical facilities (toilets and associated system requirements) and practice. Therefore, this paper adopts that the term Adequate sanitation refers not only to facilities on the site of a household (toilets) and to any pipes, treatment works etc which may be part of a public or communal disposal system, but also to the successful operation of the facilities and system.(MOH el at.2008). The term basic level of service for a household means a Ventilated Improved Pit(VIP) latrine (in its various forms, to agreed standards) or its equivalent in terms of cost, robustness, health benefits and environmental impact; together with ongoing exposure to readily understandable information about correct hygiene practices.(Ministry of Environmental Affairs and Tourism 2008). It is acknowledged that some conditions of high population density or extremely adverse geological conditions may require something other than the basic Level OF Service (LOS) described above, but this would need to be carefully assessed in the case of low income households in view of the higher running costs of other systems. National sanitation draft whitepaper issued jointly by several ministries (2008)

`Improved‘ is defined by WHO/UNICEF (2006),that includes flush toilets that feed into holding tank, piped sewer systems, septic tanks, and pit latrines with a slab. `Unimproved' toilets include flush toilets that deposit in or nearby the dwelling, hanging toilets, latrines, or the complete absence of facilities.

World Health Organization (2000) defined sanitation as group of methods to collect human excreta and urine as well as community waste waters in a hygienic way, where human and community health is not altered. Sanitation methods aim to decrease spreading of diseases by adequate waste water, excreta and other waste treatment, proper handling of water and food and by restricting the occurrence of causes of diseases. Sanitation is a system to increase and maintain healthy life and environment. Its purpose is also to assure people enough clean water for washing and drinking purposes. Typically health and hygiene education is connected to sanitation in order to make people recognize where health problems originate and how to better sanitation by their own actions.

In defining United Nation’s Millennium Development Goals (MDG) two terms are used in sanitation: improved sanitation or broader concept basic sanitation. (BPMP, 2003) Developed sanitation services are defined in WHO’s and UNICEF’s Joint Monitoring Program (JMP) “Global water supply and sanitation assessment 2000”.

According to Background paper of Millennium project (2003) Following methods are considered as developed sanitation services:

- public sewer
- septic tank
- pour-flush latrine
- pit latrine with slab
- ventilated improved pit
- ecological sanitation

According to WHO, UNICEF (2000) Following sanitation methods are considered as undeveloped:

- service or bucket latrines (where excreta are manually removed)
- public latrines
- open latrines
- excretion to environment

Basic sanitation was defined in UN's World Summit on Sustainable Development in 2002.

By the definition basic sanitation consists:

- development and implementation of efficient household sanitation systems
- improvement of sanitation in public institutions, especially in schools
- promotion of safe hygiene practices
- promotion of education and outreach focused on children, as agents of behavioral change
- promotion of affordable and socially and culturally acceptable technologies and practice
- development of innovative financing and partnership mechanisms
- integration of sanitation into water resources management strategies in a manner which does not have negative impact on the environment

2.2.1. Importance of Sanitation

Several studies have documented the significant positive effect of sanitation on reducing child diarrhea (Esrey et al., 1991; Fewtrell et al., 2005; and Waddington et al., 2009). Moreover, improved sanitation has been shown to lower the health risks related to bilharzia, trachoma, intestinal helminthes and other sanitation related diseases. In addition, improved sanitation is likely to reduce the burden of disease related to other major health issues by reducing the average stress level for the immune system, and thus strengthening the resistant to response to new infections.

Ethiopia's Head of Environmental Health has reported that the current percentage of households with access to sanitation is 28.6 per cent but that 30-80 per cent of the available pit latrines may be non-functional (Gebreselassie 2007). Though the Millennium Development Goal (MDG) target for sanitation in Ethiopia is to reach 52 per cent of all households, the Ethiopian government has ambitious plans to achieve 100 per cent coverage in hygiene and sanitation by 2012, with their new National Hygiene and Sanitation Strategy and Protocol (Gebreselassie 2007). The Protocol is based on three pillars: promoting healthy behaviour (advocacy, social mobilization, and social marketing); having an enabling social and political environment (political support, public financing and coordination); and access to the necessary products and technology (infrastructure and hygiene products) (Gebreselassie 2007). With the training of 30,000 health extension workers (9,900 already trained) and constructing and equipping health posts (Gebreselassie 2007), the government is trying to address a need that is highlighted by the United Nations Development Programme (UNDP as a critical development concern (UNDP 2006).

2.2.2. Sanitation Problemand Its Effect

One of the key factors contributing to the incidence and burden of diarrheal disease is due to lack of sanitation in a majority of developing countries (Zwane and Kremer, 2007). According to the United Nations report, more than half of the population in developing countries still lacks access to the most basic form of sanitation (United Nations 2007). The situation is most severe for Sub-Saharan African countries, where 63% of the population lacks access to basic sanitation (UNDP, 2007/2008).If flush toilets were considered the sanitation standard to be met, the number of

people lacking proper sanitation today would even total 4 billion (Black and Fawcett, 2007). These inadequate facilities, combined with unhygienic practices and a general lack of formal water supplies, as well as safe disposal of other domestic waste water, represents South Africa's sanitation problem

According to National sanitation draft white paper Republic of South Africa (2008) the effects of the sanitation problem are threefold:

Health effect - the impact of the conditions, represented by the statistics presented above, on the health of the urban and rural poor is significant in terms of the quality of life, and the education anddevelopmentpotentialofcommunities,althoughdifficultto determine accurately.(NkosasanaDalmini el at., 2008).

Economic effect - the effect on household economies is serious, keeping families in the cycle of poverty, illness, illiteracy and lost income. The national cost of lost productivity, reduced educational potential and curative health costs is a major drain on the local and national economy.(Sibusisi Bengu,2008).

Environmental effects - inadequate sanitation leads to dispersed and diffuse pollution of water sources resulting in the water/faecal disease cycle for communities with untreated water supplies, and increased downstream water treatment costs.(Dawid de Villiers el at.,2008).

According to National sanitation draft white paper Republic of South Africa (NSWPRSA) (2008), the question of sanitation, perhaps more than most development issues, needs to be seen in the context of an integrated development strategy. The impact of inadequate sanitation services on a variety of sectors needs to be fully understood. These include the effect on the water resources of the country, particularly water quality, and the effect on the health and wellbeing of the population. Sanitation goes far beyond the issue of toilets, although safe disposal of human excreta and other domestic waste water is a major and necessary requirement for safe sanitation. Personal, family and cultural hygiene practices and habits are critical. If these are unsound the upgrading of physical toilet facilities alone will not solve the problem. Therefore sanitation improvement encompasses an entire process, aimed at the home and the individual, which must include health and hygiene education as well as improving the physical infrastructure of toilet facilities, water supply and disposal of domestic waste water.(NSWPRSA,2008)

An estimated 21 million South Africans do not have access to adequate sanitation facilities. The estimated number of people who do not have adequate sanitation in urban areas is 7. 67 million(31%). Some two million people still have to rely on the bucket system which is generally not an acceptable system from a health perspective or in terms of community acceptance. Only rough estimates of service levels are available from the rural areas. It is estimated that in these areas 14.1 million people do not have adequate sanitation services which is 85% of the rural population. Those millions numbered above who do not havesafe sanitation may be using unimproved pit latrines or open filed. In addition there is a disturbing increase in inadequately designed or operated water borne sewerage systems where the impact of failure on the health of the community and the pollution of the environment is extremely serious, (South Africa Ministry of Health,2008). These inadequate facilities, combined with unhygienic practices and a general lack of formal water supplies, as well as safe disposal of other domestic waste water, represents South Africa's sanitation problem. The effects of the sanitation problem on the health of the urban and rural poor are significant in terms of the quality of life, and the education and development potential of communities.

The international Water Supply and Sanitation Collaborative Council Working Group on the Promotion of Sanitation has pointed out that millions of people die from diarrhoea every year. Many of these deaths could have been prevented by good sanitation. Diarrhoea is the primary cause of child deaths (1-4 years) in South Africa (27.4% in 1986), and the second greatest cause of infant deaths (under 1 year) after perinatal causes. Experience from national and international water and sanitation programmes has shown how essential it is to link water supply and sanitation with health and hygiene education. Only when all these are in place will real and lasting health benefits follow.(Ministry of Education el at.,2008).Because healthy and hygienic practices are so important for achieving long-lasting health benefits, sanitation improvement programmes can never be limited to the provision of toilets by government agencies. People must be convinced of the need for sanitation improvements; so much so, that they will invest their own resources into those improvements and then be concerned that all members of the family are using the facilities and using hygienic practices. (Ministry of Health el at.,2008).

In Africa, the International Rain Water Harvesting Association (IRHA) has been promoting a broadly designed platform to ensure that rainwater harvesting technologies are a fundamental part

of sustainable development. Recognizing that the majority of people in Africa suffer from poverty linked to food insecurity and scarcity of drinking water, the IRHA works to mainstream rain water harvesting as a readily available local resource in development agendas for sustained livelihoods and Millennium Development Goal implementation strategies. The IRHA stresses the importance of synergies among various Ministries of Water, Rural Development. Environment, Housing and Economic Development as well as the need for national governments to establish institutional frameworks that encompass rural, urban, peri-urban environments to promote and design five year Plans of Action on Rain Water Harvesting. Strengthening rain water harvesting networks will facilitate the promotion of and cross fertilization of knowledge, build a data base of practices and strengthen regional cooperation in the African continent. NGO, major group discussion paper on water, sanitation and human settlements,(Barbara Gemmill and Samuel Waweru 2003).

It is estimated that 4 per cent of all deaths and 5.7 per cent of the global burden of disease is caused by poor sanitation and hygiene (Pruss-Ustun et al. 2002). Roughly 1.5 million children under the age of five die from poor sanitation each year (UNICEF 2006). In this study 'Improved sanitation' refers to facilities that flush into a piped sewer system, septic tank, pit latrine, a ventilated latrine, pit latrine with slab or a composting toilet (UNICEF 2005).

Within Ethiopia, it is estimated that more than 250,000 die each year from poor sanitation, hygiene (Gebreselassie 2007), compared to the estimated 500,000 children who die each year in Ethiopia due to preventable diseases and malnutrition (UNICEF 2005).Although institutions such as the World Bank and UNICEF have dedicated considerable resources to improving sanitation around the world, 51 countries, including Ethiopia, are at risk of not meeting their sanitation target within the Millennium Development Goal number 7 for environmental sustainability (UNICEF 2008). It is estimated that approximately 2.4 billion people will remain without adequate sanitation facilities by 2015 (UNICEF 2007). Poor sanitation increases the risk of faecal-oral transmission and is a major risk factor in exposing children to pathogens and infectious diseases (Silva 2005). These pathogens and diseases can cause severe diarrhoea that claims up to 2.2 million lives per year worldwide (Rheingans et al. 2006); even where there are no symptoms, related diseases can prevent the absorption of nutrients necessary for growth and development (Checkley et al. 2004). In a study conducted by Checkley et al. (2004) in Peru,

children 24 months of age with the worst sanitation, water source and water storage had 54 per cent more episodes of diarrhea then those children with optimal conditions.

While progress towards the MDG 2015 target for access to adequate water is better than sanitation in Sub-Saharan Africa, neither is on track to reach their target. In Sub-Saharan Africa, water will miss the target by a generation and sanitation will miss the target by more than two generations (UNDP 2006). Meanwhile, the health benefits expected from improved water sources are in danger of being dampened by the lack of similar improvement in sanitation.

Diseases related to unsafe water, poor sanitation, and lack of hygiene are some of the most common causes of illness and death among the poor of developing countries. According to WHO, 1.6 million deaths every year can be attributed specifically to these health determinants.Hutton and Haller (2004) stated that each year poor sanitation contribute to 5.4 billion cases of diarrhea worldwide and 1.6 million deaths, mostly among children under the age of five. Intestinal worms—which thrive in poor sanitary conditions—infect close to 90 percent of children in the developing world and, depending on the severity of the infection, may lead to malnutrition, anemia, or retarded growth, which, in turn, leads to diminished school performance (Hotez and others 2006; UNICEF 2006). About 6 million people are blind from trachoma, a disease caused by the lack of water combined with poor hygiene practices.

The seventh MDG, ensuring environmental sustainability, includes the following target: to halve the proportion of people without sustainable access to safe drinking water and basic sanitation by 2015. Progress has been made with regard to drinking water, with global rates of access to safe water rising from 77 percent to 87 percent from 1990 to 2008. Despite this progress, sub-Saharan Africa still lags behind most of the rest of the world, as only 60 percent of the populations have access to an improved drinking water source. Worldwide, basic sanitation access is unlikely to meet global MDG standards by 2015. In sub-Saharan Africa, two-thirds of people lack access to improved sanitation facilities (UNICEF 2010). Of those who lack basic sanitation, more than one billion must practice open defecation, including 224 million people in sub-Saharan Africa (UNICEF 2010).

The rural-urban disparities emerge again in water and sanitation access. Globally, 84 percent of rural residents lack access to an improved drinking water source compared to 16 percent of urban

residents. Access to improved sanitation eludes 32 percent of people in urban areas and 60 percent of those in rural locations (UNICEF 2010).

Estimates suggest that investments in adequate sanitation facilities are exceedingly cost-efficient with regard to health returns (Montgomery and Elimelech 2007). This study examines the role of improving access to sanitation on child malnutrition, in an effort to identify cost-effective public policy solutions for combating a key component of child mortality and morbidity and to provide further incentives for investment in water and sanitation.

A study by the World Health Organization estimated that environmental risk factors account for 34 percent of the disease burden in children (Prüss-Üstün and Corvalán 2007). Unclean water, lack of sanitary facilities, and improper hand-washing and hygiene practices due to a lack of proper sanitation facilities are key environmental risk factors which are beginning to receive more attention from scholars because they are increasingly shown to influence public health significantly.(ibid).

2.3. Empirical Evidence

Three meta-studies conducted by Esrey et al. (1991) review 144, Fewtrell et al. (2005) 46, and Waddington et al. (2009) 71 articles have summarized the empirical evidence on the health impacts of improved water and sanitation. All studies compare the benefits of water infrastructure, sanitation infrastructure, water quality treatment and hygiene education using diarrhea as the main indicator of health improvements.Most of the reviewed articles in the three meta-studies emphasis on water quality treatment or hygiene education Fewtrell et al. (2005) find two studies that adequately identify the effects of sanitation infrastructure on child diarrhea. Both papers analyze the impact of a combination of latrine installation and hygiene education and/or improved water supply. The single effect of latrine infrastructure on diarrhea is not identified in either of these studies. Esrey et al. (1991) identify five, and Waddington et al. (2009) identify eight studies on sanitation infrastructure.The study explained that with regard to water infrastructure supply, the picture is not much better: Esrey et al. (1991), Fewtrell et al. (2005), and Waddington et al. (2009) include twenty-two, six and eight articles in their analysis of water infrastructure interventions, respectively. Esrey et al. (1991) find a 17% reduction in diarrhea persuaded by improved water supply and a 22% reduction persuaded by improved sanitation

infrastructure. Fewtrell et al. (2005) indicate a reduction in illness of 25% for water and 32% for sanitation infrastructure. The study explains that the results are, however, insignificant for water interventions if only diarrhea is considered as the dependent variable. Waddington et al. (2009) report no significant impact on diarrhea morbidity for water supply and a 37 % relative reduction in diarrhea incidence for sanitation infrastructure (but with low precision due to the small number of relevant studies). All three meta-studies suggest that the impact of sanitation infrastructure is larger than the health impact of improved water supply. In addition the study indicates that none of the three studies finds any evidence for complementarities between water and sanitation interventions: the impact of single interventions appears to be similar to the impact of the same interventions in combined programs.(Isabel Gunther el at.2010).The research underlying these three meta-studies were mostly based on local case studies and conducted under trial conditions. The only study that directly takes a broader cross-country perspective is an early study conducted by Esrey (1996), who uses eight Demographic and Health Surveys to identify the effects of sanitation on diarrhea. The study finds a reduction of diarrhea of 13-44% for flush toilets and a reduction of diarrhea of 8.5% for latrines. In contrast to the meta-studies discussed above, Esrey (1996) finds complementarities between water and sanitation. He shows that improved water supply has no effect on health if improved sanitation is not present and even if sanitation is present the health benefits of water are reported to be lower than the health benefits of improved sanitation. Esrey's article – undoubtedly one of the most cited works in the filed – is, however, constrained by a rather arbitrary (small) selection of DHS surveys (8 out of the 63 surveys that were already available in 1995) The eight surveys used in the study are Bolivia, Burundi, Ghana, Guatemala, Morocco, Sri Lanka, Togo, and Uganda. .(Isabel Gunther el at.2010).

Other researchers Cutler and Miller (2005) argue that water and sanitation improvements account for 50% of total, and 75% of child mortality reductions experienced in major US cities throughout the 20th century. Watson (2006) argues that sanitation investment in native Indian reservations was the key driver for the convergence in child health between native Indian and the surrounding populations in the US.It is estimated that half of the world's population, mainly in developing countries, uses solid fuels (biomass and coal) for household cooking and space heating (Rehfuess, Mehta, and Prüss-Üstün2006). Cooking and heating with such solid fuels on open fires or stoves without chimneys lead to indoor air pollution, that, in turn, results in respiratory infections Exposure to these health-damaging pollutants is particularly high among

women and children in developing countries, who spend the most time inside the household. As many as half of the deaths attributable to indoor use of solid fuel are of children under the age of five (Smith, Mehta, and Maeusezahl-Feuz 2004)

Jacoby and Wang (2003) examine the linkages between child mortality and morbidity, and the quality of the household and community environment in rural China using a competing risks approach. The key findings are that (1) the use of unclean cooking fuels (wood and coal) significantly reduces the neonatal survival probability in rural areas; (2) access to safe water or sanitation reduces child mortality risks by about 34% in rural areas; (3) a higher maternal education level reduces child mortality and that female education has strong health externalities (4) access to safe water/sanitation, and immunization reduce diarrhea incidence in rural areas, while access to modern sanitation facilities (flush toilets) reduces diarrhea prevalence in rural areas; (5) significant linkages between Acute Respiratory Infections (ARI) incidence and use of unclean cooking fuels are found using the city level data constructed from the survey.

2.4. Effects of improved water and sanitation on Diarrhea and Child Malnutrition

Among the various infections, diarrhea is one of the most prevalent in developing countries and is responsible for a high proportion of sickness and death in children under five years of age (Scrimshaw 2003). Because of its high occurrence and its involvement with the malabsorption of nutrients, diarrhea has been a key issue in child malnutrition (Mata 1992; Scrimshaw 2003). The effects of different types of malnutrition on diarrheal illness have been studied over the past several decades (Guerrant and others 1992).

In a study conducted by Rania Roushdy el at (2012) to examine the impact of improved water supply and sanitation services on childhood diarrhea in Egypt using a combination of qualitative and quantitative data, child with the worst sanitation, source of water and water storage had more episodes of diarrhea than those children with optimal condition. Based on commonly used WHO definitions, ‘Improved sanitation’ refers to facilities that flush into a piped sewer system, septic tank, pit latrine, a ventilated latrine, pit latrine with slab or a composting toilet (UNICEF 2005). Residents complained of poor water quality, low pressure, and frequent stoppages; as a result many stored water in preparation for service cutoffs. In terms of sanitation, it was found that even when households were equipped with a flush toilet and septic tanks are quite common in Egypt—

were emptied infrequently, leading to leakages. Some local disposal services were also said to dump the waste into local waterways. Rania Roushdy el at (2012) For the qualitative data, propensity score matching analysis was carried out to examine the impact of an improved-uninterrupted water source and an improved-connected sanitation facility on childhood diarrhea. Access to an improved-uninterrupted water source was found to have a significant negative effect on the incidence of childhood diarrhea, whether measured against all other cases or only against children in households with improved but interrupted water supply. Not storing water, a practice that is likely related to the consistent availability of water, was also found to have a significant negative effect on the incidence of childhood diarrhea. The negative effect of improved-uninterrupted water supply on childhood diarrhea was found to be strongest among children whose mothers had little or no education. The overall result also appears to be driven by the strong negative treatment effect in rural areas, whereas no significant effect was found in urban areas. These results indicate that interrupted water supply is an important child health issue in Egypt, particularly in rural areas and among families with mothers who had little education, and needs to be addressed.Having an improved-connected sanitation facility in the household was associated with a positive treatment effect. In other words, children with improved sanitation facilities that were connected to the public sewer system were more likely to experience diarrhea. Rania Roushdy el at (2012) stated that available EDHS data were not sufficient to determine whether this surprising result is related to the definition of the control group or the presence of septic tanks or vaults in the neighborhood that may be causing contamination. However, as with improved-uninterrupted water supply, these results appear to be driven by large treatment effects in rural areas, as the analysis in urban areas again proved insignificant.These somewhat contradictory findings lead to several recommendations for researchers concerned with water supply and sanitation. This analysis suggests that both quality of service issues and health behaviors intervene in the relationship between improved services and health outcomes. Intervening factors may include the reliability of improved services at the local level, the distribution of those services, the non- use of improved water for different types of household needs, water storage practices, the frequency of septic tank evacuation, hygiene behaviors, and awareness of accurate health information. According to Rania Roushdy el at (2012) Investing in basic WSS infrastructure, a goal toward which Egypt has made significant progress is not enough to achieve improved child health. In terms of health behaviors, the qualitative component of this

study finds that the provision of improved WSS services is not necessarily associated with improved hygiene practices. Residents were found to have more or less maintained the same frequency of washing practices and still washed dishes in canals. These findings may be attributed to two major factors. First, the inadequacy of the present services, especially in regard to water-provision regularity, may discourage residents from frequent washing. Second, respondents (especially mothers) lack awareness of the seriousness of childhood diarrhea and the important role that hygiene plays in child health. Diarrhea was also not one of the diseases residents were most concerned about in relation to WSS services.(Rania Roushdy el at,2012). Health messages regarding diarrhea need to stress the seriousness of the disease and disseminate accurate information about causes.Unobserved characteristics, perhaps stemming from the nonrandom placement of water and sanitation services, may explain the unexpected positive treatment effect found for improved-connected sanitation services. (Rania Roushdy el at.2012)

Pneumonia – the number 1 killer of young children - kills more children under- five years of age than any other illness in every region of the world. Of the estimated 9 million child deaths in 2007, around 20% or 1.8 million were due to pneumonia (WHO, 2008, World Health Statistics. Geneva, WHO, 2009).Pneumonia is the largest cause of death in children worldwide. Every year, it kills an estimated 1.2 million children under the age of five years, accounting for 18% of all deaths of children under five years old worldwide. Pneumonia affects children and families everywhere (WHO report 2013).The following environmental factors also increases a child's susceptibility to pneumonia:

•indoor air pollution caused by cooking and heating with biomass fuels (such as wood or dung)

•living in crowded homes•parental smoking (ibid).

In spite of its huge toll on human life, relatively few global resources are dedicated to tackling this problem.(UNICEF 2009). Mortality due to childhood pneumonia is strongly linked to malnutrition, poverty and inadequate access to health care. Consequently, more than 98% of pneumonia deathsin children occur in 68 countries where progress in reducing under-five mortality is most critical. The burden that pneumonia places on families and the health system in low-resource countries in turn exacerbates inequalities; overwhelmingly, children who are poor,

hungry and living in remote areas are most likely to be visited by this “forgotten killer” (UNICEF and WHO 2006).

This situation must not continue. At the Millennium Summit in 2000, the United Nations Member States committed to achieving Millennium Development Goal 4 (MD G4) – to reduce the under-five mortality rate by two thirds by 2015, compared to 1990. Since then, substantial progress has been made in reducing child mortality, but if the current trend continues, an estimated 13.2 million excess deaths will occur between 2010 and 2015. MD G4 can only be achieved by an intensified effort to reduce pneumonia deaths. If a global plan is not put in place, around 1.8 million children will continue to die from pneumonia every year. With accelerated implementation of key interventions, each year the number of pneumonia deaths will drop substantially, and by 2015, 67% of child pneumonia deaths will be averted. This reduction translates into 5.3 million lives saved from 2010 to 2015. In addition, up to 860 000 deaths due to diarrhea will also have been averted during this period, as a result of the promotion of exclusive breastfeeding intervention common to both diseases.(WHO,2009).

The Global Action Plan for Prevention and Control of Pneumonia (GAPP) has been developed in order to increase awareness of pneumonia as a major cause of child death, call for scaling up the use of interventions of proven benefit, and provide guidance on how this can be done. The GAPP calls to action a broad coalition of global and national policy-makers, donor agencies and civil society (UNICEF, 2009).

According to Niessen L et al.(2009, 87:472–480), cited on UNICEF 2009 Promote exclusive breastfeeding for 6 months evidence 15–23% reduction in pneumonia incidence, and Reduce indoor air pollution evidence relative risk reduction with liquid fuel stoves and 75% reduction in incidence in specific settings with improved solid fuel stoves . Jones G et al. (Lancet, 2003, 362:65–71). Promote exclusive breastfeeding for 6 months evidence 13% reduction in all child deaths and adequate nutrition throughout the first five years of life, including adequate micronutrient intake evidence 6% reduction in all child deaths for adequate complementary feeding (6–23 months of life).Hand washing evidence 3% reduction in all child deaths when combined with improved water and sanitation interventions.(ibid).According to UNICEF (2009) the key to reducing childhood pneumonia and achieving MD G4 is to urgently turn current knowledge into a package of effective and affordable interventions. This package will protect

children by providing an environment where they are at lower risk of pneumonia, will prevent pneumonia morbidity by applying proven interventions, and will effectively treat cases when they occur in order to reduce mortality. Most child pneumonia deaths would be prevented if this package of interventions were implemented on a broad scale and reached the most vulnerable populations. Many of the interventions in the package fall within the scope of health ministries, but some will require close collaboration with other sectors. Actions will be further enhanced by progress in eliminating poverty and protecting the quality of the environment. Most countries are already implementing at least some of the interventions needed to control childhood pneumonia, through various programmes and approach, (ibid).However, implementation thus far has been uneven and service delivery remains uncoordinated. Only 54% of children with pneumonia are reportedly taken to a qualified health care provider in developing countries. Despite the essential role of antibiotics in reducing child deaths from pneumonia, only 19% of under-five children with clinical signs of pneumonia received antibiotics (UNICEF 2009).

According to UNICEF and WHO.(2006), Only 82% of children receive their first routine dose of a vaccine against measles. UNICEF, (2009) there has been a significant reduction in measles deaths because of the provision of a second opportunity for measles vaccination through mass campaigns. Nevertheless, a risk exists that many countries will suffer increased numbers of measles cases unless global efforts to control the disease are intensified. Exclusive breastfeeding up to six months is only practiced by 34.8%3 of mothers. Low coverage prevails for other interventions also, and where coverage is poor, it is usually the children at greatest risk of pneumonia who are not covered.

UNICEF (2000) states that here are major programmatic challenges to improving this situation: identifying the best package of interventions for a particular country, defining ways to scale them up, ensuring that the highest risk communities are reached, and introducing appropriate new interventions. Creating synergy among the concerned programmes and departments within ministries of health and among other institutions that provide health services or implement complementary interventions is a particular challenge.

Because of the need to act urgently, pneumonia interventions must be prioritized at the policy and financial level, to ensure that an environment conducive to interventions is in place and that

resources are available. At the same time, delivery of key interventions needs to be integrated at the point of care, e.g. breastfeeding promotion.(UNICIFE 2009).

2.5. Empirical Evidence of Access to Water and Sanitation in Tigray

Progress in water supply and sanitation should not be viewed just in terms of achieving the specific water and sanitation of the MDGs. Access to improved water supplies and sanitation facilities, coupled with improved hygiene practices such as hand washing, are prerequisites for achieving most of the other MDGs, particularly those on child mortality reduction, achieving universal primary education, combating diseases and promoting gender equality and empowering women. The problem of clean water supply and sanitation in Tigray are wide spread and still major source of infectious and non-infectious diseases. As part of the sub Saharan Africa water and sanitation coverage in Tigray are in the lowest rates and are not on track to achieve MDGs. Relief Society of Tigray (REST).

The expansion of primary education in Tigray has entailed quality related problems. Majority of the primary schools constructed suffered from problems of shortage of potable water facility (TDA, 2009). According to Tigray Regional Bureau of Education, the total number of governmental and non-governmental primary schools increased from 1,049 in 2004 to 1,775 in 2008. As a result, home school distance ranged from 3.1 in grade one to 5.06 to grade eight. While access to primary education has been continuously improving from time to time, there exists apparent problem of shortage of potable water facility in primary schools placing heavy challenges to the smooth functioning of the school environment. The problem is so extensive that covered virtually all the rural schools in Tigrai and given the resource limitation at the disposal of the Tigrai Regional National State; it requires the involvement of all development actors. To alleviate the problem, TDA works in strong collaboration with donors, supporters and association members at home and abroad (TDA, 2009). ADF (2005) reports that potable water supply in Tigray region is low, which was only 25%.The Region's access to potable water improved to 54% in 2010. http://www.et.emb.japan.go.jp/oda-ehtm

In the past 30 years the Biblical landscape of Tigray has turned, catastrophic as deforestation, coupled with the unpredictable rains of climate change, have pushed the environment to the limits of habitability. http://www.wssinfo.org

A key concern is how – against these odds – to bring water and sanitation to pastoralists and subsistence farmers whose survival becomes more precarious with every season that passes (ibid)

Six districts of Tigray and a further 72 in the rest of Ethiopia are currently being targeted by UNICEF, the European Union (EU) and the government in a 23.1 million euro programme aimed at bringing water and sanitation to one million people in the five years leading up to 2011.(UNICEF 2010).In the village of Chila, households are, used to have to get up before daybreak to collect water from a river that was sometimes polluted. But in November 2009, under the EU-UNICEF initiative, a broken pump less than 15 minutes' walk from their house was repaired, (UNICEF report 2010). Epidemiological records show that before the EU-UNICEF programme got under way in 2006, 80 percent of all diseases affecting children in targeted areas were a result of lacking water and sanitation. One of the objectives of the sanitation programme is to reduce rates of diarrhoea and trachoma by 40 per cent.(ibid). Illnesses linked to poor sanitation not only keep children out of school on sick days but are known – in the case of parasitic amoebas – to impair their ability to learn. Schools have been a focal point of the EU-UNICEF effort in Tigray, with 156 of them having been equipped with girls' and boys' latrines.(UNICEF, 2010).

In keeping with European Union policy to work hand in- hand with government and thus to increase service delivery capacity, the EU-UNICEF scheme depends for its implementation on active input from district administrators and their staff. By 2008, coverage was about 52 per cent, up from 28 per cent in 2000. UNICEF's water, hygiene and sanitation teams are working in eight districts of Tigray and five of the district projects are supported by the EU.(UNICEF, 21010). Since 2006 when EU/UNICEF-supported health extension work began in five districts of Tigray, more than 30,000 latrines have been built. Percentage of households in the five districts which now have latrines (UNICEF. 2010).

Table 2.1Percentage of households in the five districts which have latrines

Districts	Percentage of households which have latrine
Hawzien	66
Alaje	72
EndaMekoni	81
Enderta	87
H/Wajirat	90

Source: (UNICEF. 2010)

• 924 water, sanitation and hygiene committee members, pump operators and community representatives have been trained.

• 74 shallow wells drilled and equipped with hand pumps.

• 33 wells dug and equipped with hand pumps. • 32 on spot springs developed.

• 14 existing water supply schemes rehabilitated.In Kilte-Awelailo Since 2006, Communicable deaths have reduced by 64 percent while 74 percent people have gained access to safe water. (UNICEF report,2010).

Chapter Three

Methodology and Data Sources

3.1 Area Description

Tigray region is located in the Northern part of Ethiopia and divided in to six zonal administrative .The region is sub divided in to 47 weredas with the total population of 4.6 million The total size of the region 50,078kmsquar (CSA, 2008).For this study, out of the 47 Weredas three weredasare selected. Both Adwa andHintalowajiratand Tanqua –abergele are found in the central and southern zone of Tigray national regional state respectively. Based on the 2007 national census conducted by the Central Statistical Agency of Ethiopia (CSA), Adwa,Hintalo-wejirat and Tanqua-Abergeleworedas have a total population of 99,711 of whom 49,546 are men and 50,165 are women,153,505 of whom 75,890 are men and 75,512 are women,93,185 of whom 47,512 are men and 45,673 are women respectively. The Woredas constitute Weyinadega(midland)-climate, and warm climate. Rain fall is mono modal, mainly from June to end of August, usually the highest being in July. The topography of the Woredas is characterized with an attractive landscape of undulating mountains alternating with plains. The population density per hectare of cultivable land in most of the weredas is similar i.e. 2.68. The feature of agriculture in these zones is similar in many respects with the rest part of the region. As in most parts of the region, the project Woredas are characterized by high infant and under-five mortality at 67 and 106 per 1000, respectively. The economy of the districts is entirely agricultural with small holder cultivation of cereals and pulses mainly characterized by subsistence farming mixed with livestock rearing. Oxen are the only source of traction power and among the main indicators of poverty and inequalities among farmers. The main source of money for the purchase of grain is livestock sales and off-farm employment mainly wages employment. (Wikipedia, 2012).

3.2. Data source

The study tries to see the effect of access to potable water and sanitation on rural welfare (health) by employing the secondary data obtained from REST in Adwa, Tanqua –abergele and Hintalo-

wajiratweredas under the supervision of Relief Society of Tigray in 2010/2011. REST took 199 households from the total population of the three weredas from Tanqua- abergel (74 Households), from Adwa (61 households) and from Hintalowejerat (64 houesholdes) and three tabiassuch as Seret,Mariam-shewito and Behri-tseba from the above Weredas respectively through random sampling technique.

The purpose of this survey is to gather accurate and reliable recent household information that could predict the current profile of the water supply and sanitation patterns of the population living in the three Weredas. Data collection process was undertaken through a face to face (personal) interview with the comprehensive household questionnaire. A total of 199 households are included in the survey.

3.3. Method of Data Analysis

3.3.1 Descriptive method

Descriptive method analysis is employed to explain the demographic behavior of household characteristics. It is mainly used to compare and contrast the nature of demographic and other socio-economic behavior of households in the three Weredas along with their implications on the water access and sanitation status. The specific methods of data analysis involved tabulation and cross tabulation, frequency, percentages, and computation of descriptive statistics such as mean and standard deviation.

3.3.2 Econometric Model of Analysis

Model Specification

One of the main objectives of the study is to analyze the effect of water access and sanitation on, diarrhea morbidity and pneumonia incidence reduction at household level. To examine this, binary choice model is employed to show the functional form and relationship of access to water and sanitation with rural health of the household. When the explanatory variable(s) is (are) non-continuous, one can represent them as dummy variable and proceed to non-linear regression analysis. As the dependent variable is binary, (Pindyck And Rubinfeld, 1981) a binary choice model assumes that individuals are faced with ahoice between two alternatives. Thus, one purpose of a qualitative choice with a given set of attributes would make one choice of the alternative. There are several methods to analyze the data involving binary outcomes. If the error

term is normally distributed the discriminant analysis estimator which follows ordinary least square procedures (OLS) is the true maximum likelihood estimator (MLE) and therefore asymptotically more efficient than the probit model which requires maximum likelihood method. However, if the error term is not normal y distributed, the discriminant analysis estimator is not consistent, whereas the probit MLE is consistent and therefore more robust (Maddala, 1983; Amemiya, 1981). Therefore, Hosmer and Lemeshew (1989) cited in Abebaw, (2003) pointed out that probit has advantages over the other in the analysis of dichotomous outcome variable in that it is an extremely flexible and easily usable model from mathematical point of view and results in a meaningful interpretation. Both qualitative and quantitative approaches will be used to examine the effect of water and sanitation facilities on reduction of death, sickness, diarrhea morbidity and pneumonia morbidity at household level. Although it seems plausible to use a difference in difference model for estimation in this data type , missing value of baseline data for most variables (outcome and explanatory variables) in the data set restricts the use of DID estimation model and if tried the biggest worry is that most important variables will be missing that will cause inconsistency and inefficient which in turn leads to bias estimation and wrong inferences Thus, the researcher found that DID is not an appropriate model for this data set type .Hence, the missing value of important variables forced the researcher to select one of the binary models

From the point of view of these facts, the probit function is selected for this study.

Probit model can answer the question that is a limited dependent variable Y is a binary variable, Y(0.1)Verbeek(2004) stipulated that standard normal distribution has zero mean, unit variance and its density is describe as follows

$$\emptyset(\in) = \frac{\mathbf{1}}{\sqrt{\mathbf{2}\boldsymbol{\pi}}}\boldsymbol{exp}\left(-\frac{\in^{\mathbf{2}}}{\mathbf{2}}\right)$$

The general expression of the model is as follows

$$\mathbf{y^*}=\boldsymbol{\alpha}+\boldsymbol{\beta x'}+\boldsymbol{\varepsilon}$$

Where $\begin{cases}\boldsymbol{yi}=\mathbf{1}\\ \boldsymbol{yi}=\mathbf{0}\end{cases}$ $\boldsymbol{if}$ $\begin{cases}\boldsymbol{y}^*\geq\mathbf{0}\\ \boldsymbol{y}^*<0\end{cases}$

Y* is unobserved it is referred to as latent variable.

Latent variable as opposed to observable variables are variables that are not directly observed but inferred (through a mathematical model) from other variable that are observed (directly measured).

In this study if Y*>0 marginal benefit of households from participating in package is greater than zero. Thus we find them participating in hygiene education and sanitation, they build latrine with super structure; they develop habit of liquid waste management, washing water storage and the other variables which are determinant of household welfare.

X'is the vector of explanatory variables that is supposed to determine the welfare indictors of the households

So the form shows as follows

$p(yi = 1) = \Phi(\boldsymbol{\beta} x')$

Once the factors that influence the household health are identified probit regression function is employed to show the functional form and relationship of these factors and welfare of the household.

Using the probit model the functional relationship of the dependent (diarrhea morbidity) variables and its determinants can be given by:

$pr(Y = 1/Xi) = \Phi(\beta o + \beta_1 hygien + \beta_2 bknow + \beta_3 psoap + \beta_{4educt} + \beta_5 latrine + \beta_6 hhrooms + \beta_7 adisposal + \beta_8 handwash + \beta_{9achildfece} + \beta_{10} hhandwas \beta_{11} buzzla + \beta_{12}$impst+$\beta_{13}$shelve+$\beta_{14}$vent).

Where the dependent variable Yi represents household and child diarrhea morbidity and, is the cumulative standard normal distribution function, hygiene education and sanitation practice, level of education of the household head, awareness of water contamination during storage , ….are determinants of the households welfare (health).The negative and positive signs of the coefficients of $\beta o, \beta_1 \ldots \boldsymbol{\beta_{14}}$ show that they can reduce and increase the probability of the house hold welfare respectively.

Similarly, using the probit model the functional relationship of the dependent variables (pneumonia incidence) and its determinants can be given by:

$\Pr(Y = 1/Xi) = \Phi(\alpha_0 + \alpha_1 latrine + \alpha_2 bknow + \alpha_3 handwash + \alpha_4 stov + \alpha_5 adisposal + \alpha_6 sepbarn + \alpha_7 ventlate)$

Where the dependent variable Yi represents household and child pneumonia incidence and, is the cumulative standard normal distribution function, latrine, hand washing, disposal place and awareness of water contamination during storage, ….are determinants of the households welfare (health).The negative and positive signs of the coefficients of $\alpha_0, \ldots . \alpha_7$ show that they can reduce and increase the probability of the house hold welfare respectively.

3.4. Description of Dependent and Explanatory Variables

By considering household's (including children) diarrhea morbidity and pneumonia incidence as dependent variables several variables are identified to analyze whether they explain the effect of water access and sanitation on the rural households' health.

It is suspected that some household characteristics such as educational level of household head, hygiene education and sanitation practices, number of rooms, hand washing with primary detergent, childe feces, water contamination during storage, buzzla (plenty of flies in the residence area of household) hand washing facilities building, disposal waste, hand washing facilities installed and usage and others are identified as determinant of household's welfare or household participation in the package of water access and sanitation(Yi).Yi is a dichotomous dependent variable that takes a value of 1 if the household member is sick due to diarrhea morbidity ,pneumonia incidence zero otherwise.

3.5. Demographic and Socio-Economic Variables

Sex (**gender**): this is a dummy variable which takes a value 1for a house hold if the household head is female zero otherwise. Gender differential among households play a significant role in economic performance of a given household. Some empirical studies have demonstrated that gender is important in defining the economic role of rural people in Africa (Sweeney M.D. Dy1980, Addis, et al.1999).

The empirical study made by (Sweeney M.D. Dy, 1980, Addis, et al.1999) of gender specific attitude towards family care and house management support this agreement.

Familysize: this refers to the number of persons in a given household. This variable dictates as the size of the house hold increases the likelihood of exposure increases.

Age: this variable has a continuity characteristic. It is supposed that as the house hold head gets older his/her ability and physical capacity to travel long distance to fetch water and to perform their day to day activities are expected to decrease.

Marital status: this takes value of 1for single,2 for married,3 for divorce and 4for widowed.

Many times the married individual does have huge responsibly in handling the welfare of the family. One con supposed that married households of both male and female have the responsibility to be the main bread winner of the household. Married households are more likely to expose to diarrhea and pneumonia morbidity due to shortage of potable water.

Education: This takes a value 1 for illiterate 2 for basic education 3 for (grade 1-4), 4 for (grade 5-8) and 5 for (grade 9-10). As education of household head increase by one unit measurement, the probability of diarrhea and pneumonia morbidity will reduce for both the households.

Distanceto water source/point/: this is a continuous variable and it refers to time elapsed to travel from their residence to source/point/of water.

In this case, one may suspect that females (women and girls) are more responsible to fetch water than male. Females suffer from traveling long distance to fetch water. They scarify their productive time, energy and school retention, while fetching water from long distance.

Number of rooms: This is a continuous variable .Household heads who have one room are more likely to expose to disease that spread through contamination than households with more number of rooms.

Washing water storage: this is continuous variable and household heads that wash water storage regularly can reduce the probability of water contamination at point of use.

Hand washing with soap: hand washing with primary detergent is one of the key determinants of household welfare. Respondents that practice hand washing with soap are less likely to expose to diarrhea morbidity.

Stove is one of the determinants of household welfare. One can suggest that respondents that use open stove for cooking and heatingwith biomass fuels(such as wood or dung) are more likely to expose to pneumonia incidence than those who use improved stove that reduced indoor air pollution caused by cooking and heating with biomass fuels.

Table 3.1:Summary of Variablesdescription included in the Model

No.	Name of the variables	Code	Variable type	Unit
1	Number of rooms	Hhrooms	Continuous	Number
2	Awareness of water contaminate	Bknow	Dummy	1 if yes, 0 other wise
3	Buildof Latrine in compound	Latrine	Dummy	1 if yes 0 otherwise
4	Hygieneeducation&sanitation	Hygiene	Dummy	1 if yes, 0 otherwise
5	Hand wash facilities	Handwash		1 if yes, 0 otherwise
6	Child feces cause disease	Childfece	Dummy	1 if yes, 0 otherwise
7	Disposal place	Disposal	Dummy	1 if open field 0 others
8	Hand washing facilities and usage	Handwas	Dummy	1 if regularly, 0 otherwise
9	Buzzl large number of flies	Buzzla	Dummy	1 if yes 0 other
10	Improve stove	Imstov	Dummy	1 if yes ,0 otherwise
11	Presence of shelves	Shelves	Dummy	1 if yes ,0 otherwise
12	Ventlate	Ventlate	Dummy	1 if yes, 0 others
13	Primary detergent soap	Soap	Dummy	1if use soap 0 others
14	Education	Educa2	Dummy	Can read & write

Source: Own computation from REST survey (2010/2011)

Table 3.2: Summary of outcome (dependent) variables

S.No	Name of variables	Code	Variable Type	Unit
1	Reduction in diarrhea morbidity	Diamorb	Dummy	1 if yes, 0 other wise
2	Pneumonia morbidity	Disick	Dummy	1 if yes, 0,otherwise

Source: Own computation from REST survey (2010/2011)

Reduction of Diarrhea

Reduction of diarrhea in households including children in the last four weeks is the outcome of interest in this analysis .This variable act as a proxy for water quality, because as was briefly outlined in the introduction safe water supply, adequate sanitation services and hygiene education reduces diarrhea morbidity.

Incidence of pneumonia

Incidence of pneumonia in households including children in the last four weeks period is the outcome variable in this analysis.

Chapter Four

Results and Discussions

This chapter presents descriptive statistics results and econometric outcomes. By applying selected theoretical model which is discussed in the methodology different factors that are identified as a major determinant of household welfare were described .Hence, before discussing the econometric result obtained through the probit model, it is essential to explain the demographic and socio-economic variables using statistical methods of analysis.

4.1. Household Demographic Characteristic

Out of the total sample size respondents (199) 45.23% of them are male headed households while 54.77% are female headed households.

Table 4.1: Classification of household heads by Sex

Sex	Frequency	Percent	Cumu.%
Female	109	54.77%	45.23
Male	90	45.23%	100
Total	199	100	

Source: Own computation from REST survey (2010/2011)

Of the 74 household heads from Tanqua 49% of them are male headed While 51% are female headed.Similarly of 61 household heads from Adwa 61% of them are male headed while 39% are female headed.Likewise of the 64 household heads from Hintalo-wajirat 27% of them are male headed while 73% are female headed. In this weredanumbers of female household heads are more than male household heads. The possible suggestion is that it may be due to divorce, migration of male and due to ware. Thus in Hintalo-wajirat different tasks such as economic performance, family care and house management are laid in the shoulder of females than males. Gender differential among households play a significant role in economic performance of a given household. Some empirical studies have demonstrated that gender is important in defining the

economic role of rural people in Africa (Mc.Sweeney; Dy1980 Addis, et al.1999). The empirical study made by (Mc.Sweeney; Dy1980 Addis,

et al.1999) of gender specific attitude towards family care and house management support this agreement.

Table 4.2.Sex of household head in each wereda

Wereda	Male	Female	Total
Tanqua	36	38	74
Adwa	37	24	61
H.wejerat	17	47	64
Total	90	109	199

Source: Own computation from REST survey (2010/2011)

From the total household heads 56.28% household heads are illiterate meaning that un able to read and write where as 22.11% household heads are literate that they can read and write and 10.55% household heads are grade 1-4,7.54% household heads are grade 5-8 and 3.52% are grade 9-10.

Table 4.3: Education status of household heads

Educational level	Frequency	Percent	Cum.
Illiterate	112	56.28	56.28
Basic	44	22.11	78.39
Grade 1-4	21	10.55	88.94
Grade 5-8	15	7.54	96.48
Grade 9-10	7	3.52	100
Total	199	100	

Source: Own computation from REST survey (2010/2011

When we grasp the education level in each weredas, of the74 household heads from Tanqua 39 household heads are illiterate 21 household heads have able to write and read, seven household heads aregrade 1-4, five household heads are grade5-8 and two household heads are grade 9-10.In a similar way out of 61households from Adwa 35 household heads are illiterate, 12

household heads have able to read and write, seven household heads are grade 1-4, five household heads are grade 5-8 and two households are grade9-10.

When we see education level in Hintalo-wejerate out of 64 household heads 38household heads are illiterate, 11household heads have able to read and write, seven household heads are grade 1-4, five household heads are grade 5-8 and three household heads are grade 9-10.One can understand that in the case of by education comparison except in basic education they are nearly in the same education level.

Table 4.4: Household head education in each weredas

Educational status	Wereda			
	Tanqua	Adwa	Hintalo w	Total
Illiterate	39	35	38	112
Basiceduc	21	12	11	44
grade (1-4)	7	7	7	21
grade(5-8)	5	5	5	15
grade(9-10)	2	2	3	7
Total	74	61	64	199

Source: Own computation from REST survey (2010/2011)

The average age of the household head is 41years with a range of 41 to 55 years. The age structure of the surveyed household heads show that 2.51% of the household heads are lay in the age group range of 15-25years, 31.16% of the household heads are in the range of 26-40 years, 40.70% of the household heads are in the range of 41-55years, 21.11% of the household heads are in the range of 56-70 years and the remaining 4.52% are above the age of 70 years as show in the table 4.5

Table 4.5: Age category of the household heads

Age group	Frequency	Percent
15-25	5	2.51
26-40	62	31.16
41-55	81	40.70
56-70	42	21.11
>70	9	4.52
Total	199	100

Source: Own computation from REST survey (2010/2011)

The age profile of 74 house hold heads from Tanq shows that 29.73% of the household heads lay in the age group range of 26-40 years, 45.95% of the household heads are in the range of 41-55 years, 18.92% of the household heads are in the range of 56-70 years and 5.4% are above the age of 70 years as shown in table 4.6.Likewise, out of the61 household heads from Adwa, one household head is in the age range of 15-25 years, 21.31% of the household heads are in the age range of 26-40 years, 42.62% of the household heads are in the range of 41-55years, 27.87% of the household heads are in the age range of 56-70 years and 5.6% of the household heads are above 70 years.In the same manner of the 64 household heads from Hintalo-wejerat 6.25% of the household heads lay in the age range of 15-25years, 42.19% of the household heads lay in the age range of 26-40 years, 32.81% of the household heads lay in the age range of 41-55years, 17.19% of the household heads lay in the age range of 56-70 years and one household head is greater than 70 years old.

The large number of household heads of Tanqua and Adwa lay in the age range of 41-55 years, whereas the large numberof household heads of Hintalo-wajerat lay in the age range of 26-40 years. There are four household heads in Tanqua and Adwa weredas whose age is greater than 70 years whereas only one household head in Hintalo-wejerat aged 70years. One can suppose that as the household head gets older his capacity is expected to decrease, for instance inability to work long hours, to travel long distance to fetch water his physical capacity is expected to decrease, easily affected by exposures.

Table 4.6: Age category of households in each sample weredas

Wereda	Age category					Total
	15-25	26-40	41-55	56-70	>70	
Tanqua	0	22	34	14	4	74
Adwa	1	13	26	17	4	61
H.wejerat	4	27	21	11	1	64
Total	5	62	81	42	9	199

Source: Own computation from REST survey (2010/2011)

The average family size of the sample respondents is nearly in the range of 4up to 6 members.

Of the total 199 household heads 20.60% of the household heads have one-three members, 47.74% household heads have four-six members, and 29.65% household heads have seven-nine members, whereas 2.01% household heads have above 9 members.The average family size of the sample respondents was two (4-6) with a range of one-four members.

Table 4.7.Family size of the household

Families	Frequency	Percent	Cumu.
1-3	41	20.60	20.60
4-6	95	47.74	68.34
7-9	59	29.65	97.99
>9	4	2.01	100
Total	199	100	

Source: Own computation from REST survey (2010/2011)

Family size of household heads in the sample weredas:

From the total sample of 74 household heads from Tanqua 10 households have 1-3 members, 37 households have 4-6 members, 24 household heads have 7-9 members and three household heads have more than 9 members.

Similarly, of the total 61 sample households from Adwa 12household heads have 1-3 of members, 28 household heads have 4-6 of members, 21 household heads have 7-9 of members and no household head have more than 9 members.

Likewise 64 household heads from Hintalo-wejerat 19 household heads have 1-3 of members, 30 household heads have 4-6 of members, 14 household heads have 7-9 members and one household head have more than 9 members.

Table4.8 Family size of households in the three weredas

Family size of house holds	Tanqua	Adwa	Hintalo w	Total
1-3	10	12	19	41
4-6	37	28	30	95
7-9	24	21	14	59
>9	3	0	1	4
Total	74	61	64	199

Source: Own computation from REST survey (2010/2011)

Large numbers of household heads have 4-6 members. From this one can suggest that house hold heads that have 4-6 of members are more likely to expose to diarrhea morbidity and other water and sanitation related diseases than household heads with 1-3,7-9 and more than 9 number of families.

Table 4.9: Family size versus diarrhea morbidity

Family size of Households	Reduction of diarrhea morbidity		
	No	Yes	Total
1-3	11	30	41
4-6	35	60	95
7-9	20	39	59
>9	2	2	4
Total	68	131	199

Source: Own computation from REST survey (2010/2011)

Out of 41 household heads with 1-3 members, 11 of them have one room, 10 of them have two rooms, 14 of them have three rooms and 6 of them have more than four rooms. Similarly, out of 95 household heads with 4-6 members, 17 of them have one room, 37 of them have two rooms, 32 of them have three rooms and only 9 of them have more than four rooms. In the same manner out of 59 household heads with 7-9 members, 5 of them have one room, 21 of them have two rooms, 14 of them have three rooms, whereas19 of them have more than four rooms. Similarly, out of 4 household heads with more than 9 members one household head has one room and three house hold heads have three rooms (table 4.10).From this one can suggest that a unit increase in number of rooms associate with more than a unit increase in number of families, that is family member increase more than number of rooms. Thus, in this case number of rooms might not have positive effect on reduction of diarrhea morbidity and other related disease that occurred due to problem of rooms.

Table 4.10: Family size versus number of rooms

Family size	Number of rooms				
	One	Two	Three	above four	Total
1-3	11	10	14	6	41
4-6	17	37	32	9	95
7-9	5	21	14	19	59
>9	1	0	3	0	4
Total	34	68	63	34	199

Source: Own computation from REST survey (2010/2011)

From the total household heads under consideration 151 household heads were married, 26 household heads were widowed, 20 household heads were divorced and 2household heads were single.

Table 4.11: Marital status of household heads

Maritalstatus	Frequency	Percentage
Single	2	1.01
Married	151	75.88
Divorced	20	10.05
Widowed	26	13.07
Total	199	

Source: Own computation from REST survey (2010/2011)

When we grasp this in each weredas out of 74 household heads from Tanqua –abergele 62 household heads are married, 5 household heads are divorce and seven household heads are widowed. Similarly of the 61 household heads from Adwa 50 household heads are married, two household heads are divorce and 8 household heads are widowed. Likewise out of 64households from Hintalo-wjerat 1household head is single, 39 household heads are married, 13 household heads are divorce and 11household heads are widowed. From this we can understand that majority of the house hold heads in the mentioned wereds are married. Whereas divorced household heads in Hintalo-wejerat are more than the sums of the rest two weredas.

Many times married individual perform different tasks, and does have huge responsibilities in handling the welfare of the families.

Table 4.12.Household head marital status in each sample weredas

Marital st	Wereda			
	Tanqua	Adwa	Hintalo w	total
Single	0	1	1	2
Married	62	50	39	151
Divorce	5	2	13	20
Widowed	7	8	11	26
Total	74	61	64	199

Source: Own computation from REST survey (2010/2011)

Regarding to residential housing of the study area, households having two rooms on average are prevailed with arrange of 1to4 rooms (table 4.10).The mean number of rooms of tabiaSeret,Mariam- shwito and Bahir-tseba household is 2.8,2.88,and 1.75 with standard deviation of .84, 0.90 and 0.73 respectively. There is a variation in number of rooms between the tabias and within the tabias.Households who live in tabia Mariam shewito have more rooms than households who live in tabiaSeret and tabiaBahiretseba. Relatively households who live in tabiaSeret have more rooms than households who live in tabiaBahretseba.One can suspect that house hold heads that have more rooms are more likely to live in a better house .The probability of transmission of disease through contamination like diarrhea cough skin disease is less compare with those who have less room.

Table 4.13: Average number of rooms in each tabia

Tabia	Mean	Std.dev	Frequency
Seret	2.8	.83	75
m/shewito	2.88	.90	60
b/tseba	1.75	.73	64
Total	2.49	.97	199

Source: Own computation from REST survey (2010/2011)

Since p value equal to 0.0000 is much less than 0.05 we reject the null hypothesis that says the coefficient of number of rooms are zero. 37.64>3.0

Table 4.14: Analysis of variance of households' number of rooms

Source	SS	Df	MS	F	Pro>f
b/n groups	51.53	2	25.76	37.64	0.0000
Withingroups	134.18	196	.68		
Total	185.72	198	.94		

Source: Own computation from REST survey (2010/2011)

The mean age of the household head in tabiaSeret is 41-55 and the mean age of household head in Mariam shewito and Bahire-tseba is 41-55 and 26-40 respectively. Hence,one can deduced that the mean age of the household heads in the twotabias is nearly equal.

Table 4.15: Average age of the household head in each tabia

Tabia	Mean	Std.dev	Frequency
Seret	41-55	.83	75
M/shewito	41-55	.90	60
B/tseba	26-40	.89	64
Total		.89	199

Source: Own computation from REST survey (2010/2011)

Since the calculated F value is greater than critical F value, that is 5.5>3 and p value =0.0046 is less than 0.05 we reject the null hypothesis at 2 degree of freedom that says the coefficient on

household age is equal to zero and we accept the alternative hypotheses coefficients with coefficient of household age equal not zero.

Table 4.16: Analysis of variance of households' age

Source	SS	Df	MS	F-test	Pro>f
b/n groups	8.50	2	4.25	5.53	0.0046
Within groups	150.77	196	.769		
Total	159.27	198	.769		

Source: Own computation from REST survey (2010/2011)

Table 4.17: Summary of same selected variables

Variables	Obs	Mean	St.dv.	Mini	Maxi
Hsex=sex of household head	199	.54	0.49	0	1
Famils=family size of the household head	199	2.1	0.75	1	4
Hhedu=-household heads educational status	199	1.7	1.10	1	5
Psoap=soap as primary detergent to wash hand	199	.74	0.43	0	1
Latrine=latrine construction	199	.84	0.35	0	1
Hand wash=hand wash facilities	197	.80	0.39	0	1
childfaece=aw children'faece that can cause disease	199	.49	0.50	0	1
Disposal=disposal place (open filed)	199	.18	0.38	0	1
Doysepb=separate barn for animals	198	.78	0.41	0	1
Buzzla=buzzing large number of flies in residence area	199	.20	0.40	0	1
Impstove= improved stove	199	.42	0.49	0	1
Ventlate=windows for ventilation house	199	.66	0.47	0	1
Hygiened=-hygiene education and sanitation	199	.95	0.20	0	1
Hhage=age of household head	199	0.95	0.20	1	4
bknow=awareness of water contamination	199	0.75	0.42	0	1

Source: Own computation from REST survey (2010/2011)

4.2. EconometricAnalysis Result

4.2.1 Result on Diarrhea Morbidity Reduction

As already mentioned in the methodology section this study employs the probit model to estimate the parameters of the determinants of household welfare in the study area. The result of maximum likelihood estimation of the probit model showed that hygiene education and sanitation practices, hand washing with primary detergent (soap), latrine, childe feces, water contamination during storage, buzzla (buzzing plenty of flies in the residence area of households), hand washing facilities building, disposal waste, hand washing facilities installed and usage and education have significant effect on the household health (welfare). Thus, the above variables were found to be significantly creating variation on household health.

The description and effects of the significant explanatory variables on household health is discussed here under

Hygiene education and sanitation practices: the study result revealed that hygiene education and sanitation practice by the households is one of the main determinants of households' health and it is significant at 1% level of significance with positive effect on diarrhea reduction. This is due to the fact that hygiene education and sanitation practices by households reduce the health risk. For households that practice Hygiene education and sanitation, diarrhea morbidity is reduced by 54%, other variables keep constant.

This finding is similar to the finding by (Esrey et al., 1991; Fewtrell et al., 2005; and Waddington et al., 2009).They analyzed the positive effect of Hygiene education and sanitation on diarrhea reduction. Moreover they stated that improved sanitation has been shown to lower the health risks related to bilharzia, trachoma, intestinal helminthes and other water and hygiene education and sanitation related diseases.

Education level of the household head: the study result indicates that the level of education of the household head is one of the determinants of households' welfare and it is significant at 5% level of significance with negative relationship to diarrhea reduction. This is due to the fact that educational attainment by the householdsmay lead to awareness of the possible advantage of access of potable water, sanitation and hygiene education practices on their welfare. Whereas in

this study out of 199 household heads 112 are illiterate, at least they unable to read and write and 44householdheadsare with ability of only basic education that is at least they are not attained grade (1-4).Thus basic education level does not reduce diarrhea morbidity.

Awareness of water contamination during storage: The study result reveals that awareness of water contamination during storage is one of the important determinant of household 'health and it is statistically significant at 5% and it has a positive effect in diarrhea morbidity and pneumonia incidence reduction. Diarrhea morbidity is reduced by 20% for the households who have awareness of water contamination during storage other variables keep constant.

Primary detergent to wash hands (soap): the result of the model indicates that hand washing with primary detergent is one of the key determinants of household welfare and it is highly significant at 1% level of significant with positive effect in diarrhea reduction. For the respondents that practice hand washing with primary detergent (soap) diarrhea morbidity is reduced by 36%

Effect of child feces (a child faeces) the result of this study revealed that child feaces is one of the determinant variables of households welfare and it is highly significant at 1% level of significance with positive relationship in diarrhea reduction. Diarrhea morbidity is reduced by 26% for respondents who know children'sfaeces can cause disease, ceteris paribus. This is due to the fact that households who are awardee of children's faceces that can cause disease did not use open filed to waste disposal rather they keep personal, family and environment hygiene..

Buzzing large number of flies in the residence area (buzz): result of the study showed that this is also a determinant variable of household welfare and it is statistically highly significant at 1% with negative effect in diarrhea reduction. For the respondents who replied that there is buzzing large numbers of flies in their residence area diarrhea morbidity is increased by 36%, other variables keep constant. Hand washing facilities building (hand wash) according to the study result building (constructing) hand washing facilities did not play an active role in diarrhea morbidity reduction. This is due to the fact that constructing hand washing facility did not necessarily imply its proper usage by households. In this case households may use open filed though they construct hand washing material.

Hand washing facilities installed and usage (hand was) the study result indicates that hand washing facilities and usage is one of the determinant factor of households health and it is

significant at 5% level of significant with positive effect in diarrhea reduction. For households that have washing facilities installed and usage diarrhea morbidity is reduced by 23%, other variables holding constant. This finding is supported by Esrey (1996), and he stated that lower diarrhea morbidity prevalence is the most direct presumed effect of improved water and sanitation infrastructure.

Table 4.18: Estimatesof probit Model on Diarrhea Reduction

Y1diarrhea Variables	Coef	Std err	P>|z|
Hygiene	1.54***	.58	0.008
Know	.47**	.25	0.064
Psoap	.98***	.27	0.000
Latrine	-.34	.35	0.384
hand wash	-.66**	.36	0.043
child.feces	.73***	.23	0.001
Disposal	-.13	.26	0.654
hand was	.64**	.29	0.037
Buzzla	-.84***	.26	0.001
Imp stove	.06	.23	0.978
Ventlate	-.16	.22	0.460
edu2	-.55**	.25	0.030
Const	**-.16**	**0.67**	**0.016**

Number of obs	=196
LR chi2(14)	=50.46
Prob> chi2	=0.0000
Pseudo R2	=0.2364
Unrestricted Log likelihood	=-101.30
Restricted Log likelihood	=-99.00

*** p<0.01, ** p<0.05, * p<0.1

LR With the constant variables: while the Xi s are zero the effect comes from ceteris paribus variables (constant variables).

LR without constant terms the effect comes from the explanatory variables only.

Table 4.19: Marginal effects after probit

Diarmorb	dy/dx	Std.err	P>|z|
hygined*	.54***	.15	0.001
bknow*	.18**	.10	0.047
pssoap*	.36***	.10	0.000
latrine*	-.11	.10	0.295
handwash*	-.21**	.09	0.030
achild~e*	.26***	.07	0.001
adispo~l*	-.04	.11	0.660
handwas*	.23**	.11	0.034
buzzla*	-.36***	.10	0.001
imstove*	.02	.0.1	0.978
ventlate*	-.0.5	.07	0.455
educa2*	-.20**	.09	0.034

(*) dy/dx is for discrete change of dummy variable from 0 to 1

***,p<0.1,**p<.0.05,*p<0.01

Marginal effects after probit y = Pr(diamorb) (predict) = .679

4.2.2. Result on Pneumonia Morbidity

The result of maximum likelihood estimation of probit model revealed that latrine, awareness of water contamination during storage, hand wash facilities building and improved stove have significant effect on pneumonia incidence reduction.

Latrine with supper structure in households' compound: based on the study result pneumonia incidence is reduced by 22% for those households that build latrine with supper structure on their compound other variables hold constant.

Awareness of water contamination during storage (know): The study result revealed that awareness of water contamination during storage is one of the important determinants of household head welfare and it is statistically significant at 5%. Pneumonia incidence is reduced by 11% for the house holds who have awareness of water contamination during storage other variables keep constant. Hand washing facilities building (hand wash) based on the study result building hand washing facilities alone did not reduce incidence of pneumonia. Besides the access, it necessitates proper usage of the apparatus.Presenceofstove: the study result indicates that presence of stove is determinant of household welfare and it is statistically significant at 5% with negative relationship in pneumonia incidence reduction. For the respondents that use open stove for cooking and heating with biomass fuels (such as wood or dung) are more likely to expose to pneumonia incidence than those who use improved stove that reduced indoor air pollution caused by cooking and heating with biomass fuels. Pneumonia incidence is increased by11% for those who use fire wood with open stove. According to WHO report (2013) Pneumonia affects children and families everywhere. The following environmental factors also increase a child's susceptibility to pneumonia:

•indoor air pollution caused by cooking and heating with biomass fuels (such as wood or dung)

•living in crowded homes

•parental smoking (WHO report (2013).

According to Niessen L et al.(2009, 87:472–480) Promote exclusive breastfeeding for 6 months evidence 15–23% reduction in pneumonia incidence, and Reduce indoor air pollution evidence relative risk reduction with liquid fuel stoves; 75% reduction in incidence in specific settings with improved solid fuel stoves.

Table 4.20: Estimates of Probit Model on PneumoniaIncidence

Y2pneumonia	Coef	Stderr.	P>|z|
Latrin	-.91**	.43	0.037
Bknow	-.54**	.27	0.043
Hand wash	1.04**	.47	0.029
Imp stove	.58**	.27	0.032
Disposal	.37	.37	0.320
Doysepb	.60	.41	0.148
Ventlate	. 39	.30	0.199
Cons	-2.0	.63	0.001

LR chi2 (7) = 25.24 Number of obs =196

Prob>chi2 = 0.0007 Log likelihood =-65.94961 ***

p<0.01, **, p<0.05,*p<0.10

Source: Model output based on data 2010/11

Table 4.21: Marginal effects after probit

Y2pneumonia	dy/dx	Std. Err.	P>|z|
Latrine*	-.22	.13	0.101
Bknow*	-.11*	.06	0.080
Handwash*	.12***	.04	0.002
Imp stove*	.11**	.05	0.041
Disposal*	.07	.08	0.384
Doysepb*	.08*	.04	0.057
Ventlate*	.06	.04	0.162

(*) dy/dx is for discrete change of dummy variable from 0 to 1

*** p<0.01, **, p<0.05,*p<0.10

Marginal effects after probit y = Pr(pneumonia)(predict) = .0952

4.2.3. Test for Multi Colinearity

Prior to the estimation of the parameters of the model, it would be necessary to check the problem of multicollinearity or associations among the potential explanatory variables. If there is multi coliniarty problem standard errors are inflated (Wooldridge, 2003).

Hence, the existence of serious problem of multicoliniarty among the variables is examined by the help of variance inflation factor (VIF).The value of VIF greater than 10 reveals strong correlation. Based on the results of VIF the data had no problem of multicollinearity. This is because of the fact that for all explanatory variables the values of VIF are much less than 10, in other words all of the variables are original to each other or completely uncorrelated with each other; the VIF is close to one. Similarly the contingency coefficient results revealed absence of strong association between the explanatory variables; since the coefficients are very low (less than 0.75) as given on the annex. Hence the variables are included in the model because the model witnessed that there was no multicolinearity problem because for all the explanatory variables the values of VIF and CC are less than 10 and 0.75 respectively.

Chapter Five

Conclusion and Recommendations

5.1. Conclusion

In this paper, the researcher use a data from three weredas of Tigray namely Tanqua-abergele, Adwa and Hintalo –wejeratunder supervision of Relief of society for the period 2010/11 to identify the effect of potable water and sanitation on diarrhea morbidity and pneumonia incidences reduction on household level.

Understanding the factors that influence the households' welfare is useful for future policy design. This study attempts to identify and analyze the determinants of household welfare in the three weredas of Tigray.The results of this study shows that the health benefits generated from potable water and sanitation are significant. In the study, we find that access to potable water and sanitation reduces morbidity of diarrhea and incidence of pneumonia at the household level that is household heads these exercise hygiene education and sanitation practices and construct Latrine with supper structure in their' compound diarrhea morbidity and incidence of pneumonia is reduced by 54 percent and 22 percent, respectively. In the light of the results presented in this paper, the focus of the study on water infrastructure and sanitation appears significant. One reason for this preference is certainly the health risk reduction - and hence economic benefits - that come along with improved water infrastructure.

As thoroughly discussed in chapter four, the data were analyzed using both descriptive and econometric methods.Probit model econometric procedure was employed to analyze the effects of different explanatory variables on households' health.

The variables found to be significant include: hygiene education and sanitation practices, awareness of water contamination during storage, soap as primary detergent ,hand washing facilities installed and usage, awareness of households that children's feces can cause disease, hand washing facilities build, Buzzing large number of flies in the residence area and education level of household head .

The vital role of access to water and sanitation and hygiene practice in rural and urban livelihoods should be appreciated as water and hygiene education are an essential factors for reducing diarrhea morbidity and pneumonia incidence through attaining and enhancing people's health.

Sanitation goes far beyond the issue of toilets, although safe disposal of human excreta and other domestic waste water is a major and necessary requirement for safe sanitation. Personal, family and cultural hygiene practices and habits are critical. If these are unsound the upgrading of physical toilet facilities alone will not solve the problem. Therefore sanitation improvement encompasses an entire process, aimed at the home and the individual, which must include health and hygiene education as well as improving the physical infrastructure of toilet facilities, water supply and disposal of domestic waste water. The provision and improvement of adequate sanitation affects all members of society. It must therefore be addressed in a coherent and consistent way in all contexts. The environment should be addressed in a holistic manner and therefore all natural resources, of which water is the most important element, should be conserved and protected.

A basic requirement is that sanitation systems, whether on-site or waterborne sewerage, must be environmentally sound. Improved sanitation facilities will only achieve a parallel reduction in diarrheal diseases if they are developed alongside hygiene programmes.

5.2. Recommendations

Based on the findings of the study, the following recommendations are drawn.

1. The results of the model revealed that hygiene education and sanitation practices play a great role in diarrhea morbidity reduction. Thus more attention should be given to increase its coverage. Thewereda municipality has to design strategies for a coordinated and organized intervention between different stakeholders such as the NGOs, community based organizations, charity and religious organizations and community at large to enhance hygiene education and sanitation practices and to coordinate with wereda health office and wereda health extension workers to raise community awareness on sanitation and closely follow up how they exercise.

2. According to the probit analysis result awareness of water contamination during storage is one of the main determinants of household welfare. It is necessary to make households aware of water that is safe at the point of delivery cannot guarantee for not re-contaminated during collection and storage. To minimize such risk, households should practice improved collection and storage. That is using clean and appropriate collection and storage containers, or treatment at the point of use.

3. The result of this study revealed that know how about child feces that can cause disease is one of the determinant variables of household welfare. A lack of access to improved sanitation is frequently associated with disposal of human feces in public spaces. Therefore, improvements in sanitation are also likely to the benefit of neighboring households. Thus, the house holds should be responsible not to use open field to waste disposal.

4. Based on the result of the model hand washing with soap is one of the key determinants of household welfare. Access to improved water and sanitation facilities, coupled with improved hygiene practices such as hand washing, are prerequisites for achieving most of the other MDGs, particularly those on child mortality reduction, achieving universal primary education, combating diseases and promoting gender equality and empowering women. Hence, the society ought to bearing attitudinal change to wards hand washing with soap.

This study suggests that projects to improve sanitation and access to potable water should be given greater consideration and that the benefits from reduced household diarrhea morbidity and pneumonia incidence should be included in cost-benefit analyses of water and sanitation project.

5.3. Issues for Further Research

A complete analysis of effects of access to potable water and sanitation on rural welfare (health) requires an in depth and intensive investigation of household characteristics which leaves a room for new researches on the same issue.

A complete analysis of effects of access to potable water and sanitation on rural welfare (health) requires an in depth and intensive investigation of the demographic and socio-economic factors along with comparative analysis across regions. But due to lack of data, this study did not involve in regional comparison. This invites for new researchers to conduct further studies on the same issue.

This study dealt with effects of access to potable water and sanitation on rural welfare (health) at appoint in time .This is because of lack of panel data need for dynamic investigation. This may limit the dependability and representativeness of the outcome investigated over time. Such problems can bebetter addressed by using panel data for conducting longitudinal level studies.

Finally because of shortage of time and financial resources the study used secondary data. Therefore, further research has to be conducted to assess the effects of access to potable water and sanitation on rural welfare (health) using primary data.

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Annexes

Annex 1. Probit Regression on Diarrhea Reduction

(Y1)diarrhea	Coef	Std err	P>|z|
Hygiene	1.54***	.58	0.008
Know	.47**	.25	0.064
Psoap	.98***	.26	0.000
Latrine	-.34	.35	0.384
hand wash	-.66**	.36	0.043
child.feces	.73***	.23	0.001
Disposal	-.13	.26	0.654
hand was	.64**	.29	0.037
Buzzla	-.84***	.26	0.001
Imp stove	.05	.24	0.847
Ventlate	-.16	.22	0.460
edu2	-.54**	.25	0.037
Const	**-.1.6**	**0.67**	**0.016**

```
Number of obs                    =196
LR chi2(12)                      =50.46
Prob> chi2                       =0.0000
Pseudo R2                        =0.2000
Log likelihood                   =-101.30

*** p<0.01, ** p<0.05, * p<0.10
-------------------------------------------------------------------------------
```

Source: Model output based on data, 2010/11

Annex 2. Marginal Effects After Probit

Diarmorb	dy/dx	Std.err	P>|z|
hygined*	.54***	.14	0.000
bknow*	.18**	.10	0.047
pssoap*	.36***	.10	0.000
latrine*	-.11	.10	0.295
handwash*	-.23**	.09	0.030
achild~e*	.27***	.07	0.001
adispo~l*	-.09	.11	0.664
handwas*	.26**	.11	0.034
buzzla*	-.39***	.10	0.001
imstove*	.02	.01	0.847
ventlate*	-.05	.07	0.890
educa2*	-.20**	.09	0.034

(*) dy/dx is for discrete change of dummy variable from 0 to 1

***,p<0.1,**p<.0.05,*p<0.01

Annex 3: Probit Regression on Pneumonia Incidence

Y2pneumonia	Coef	Stderr.	P>|z|
Latrin	-.91**	.43	0.037
Bknow	-.54**	.27	0.043
Hand wash	1.04**	.47	0.029
Imp stove	.58**	.27	0.032
Disposal	.37	.37	0.320
Doysepb	.60	.41	0.148
Ventlate	. 39	.30	0.199
Cons	-2.0	.63	0.001

LR chi2(7) = 25.24 Number of obs =196

Prob>chi2 = 0.0007 Log likelihood = -65.94961

*** p<0.01, **, p<0.05,*p<0.10

Source: Model output based on data 2010/11

Annex4:Marginal Effects After Probit

Y2pneumonia	dy/dx	Std. Err.	P>|z|
Latrine*	-.22	.13	0.101
Bknow*	-.11**	.06	0.080
Handwash*	.12**	.04	0.002
Imp stove*	.11**	.05	0.041
Disposal*	.07	.08	0.384
Doysepb*	.08*	.04	0.057
Ventlate*	.06	.04	0.162

(*) dy/dx is for discrete change of dummy variable from 0 to 1

*** p<0.01, **, p<0.05,*p<0.10

Annex 5:ContingencyCoefficient for Dummy Variables

	hygiene	hhrooms	Bknow	pssoap	Latrine	handwash	achild~e
hygiene	1.0000						
Hhrooms	-0.14	1.0000					
Bknow	0.08	0.10	1.0000				
Pssoap	0.32	0.03	0.05	1.0000			
Latrine	0.11	0.74	0.08	0.04	1.0000		
Handwash	0.00	0.55	0.75	0.02	0.00	1.000	
achild~e	0.07	0.10	0.23	-0.28	0.05	0.06	1.000
Adisposal	-0.02	-0.10	-0.07	-0.11	-0.34	-0.34	0.02
Handwas	0.17	0.06	-0.13	0.14	0.40	0.60	0.04
Buzzla	0.11	-0.02	0.11	-0.22	0.04	-0.06	0.16
Imstove	0.03	0.02	0.05	0.23	0.21	0.15	0.00
Shelves	-0.04	0.13	0.03	-0.00	0.03	-0.04	0.02
Ventlate	0.04	0.13	0.07	-0.02	0.11	0.03	0.17
educa2	-0.05	-0.00	-0.12	0.11	-0.01	-0.04	-0.02

Variable	Adisposal	handwas	Buzzla	imstove	shelves	ventlate	educa2
Adisposal	1.0000						
Handwas	-0.37	1.0000					
Buzzla	-0.04	0.00	1.0000				
Imstove	-0.19	0.25	0.26	1.0000			
Shelves	0.04	-0.02	-0.21	0.25	1.0000		
Ventilate	0.03	0.16	-0.03	0.24	0.17	1.0000	
educa2	0.0001	-0.14	0.02	-0.01	-0.03	-0.15	1.0000

Source: Own computation from REST survey (2010/2011)

Annex 6: VarianceInflator Factor

Variable	VIF	1/VIF
Handwash	2.04	0.490330
Handwas	1.97	0.506652
Latrine	1.54	0.649237
Imp stove	1.35	0.740567
Disposal	1.30	0.766776
Psoap	1.30	0.769005
Buzzl	1.24	0.804345
Bknow	1.22	0.820108
Achildfece	1.21	0.826166
Ventlate	1.20	0.836655
Shelves	1.16	0.863145
Hhrooms	1.14	0.879575
Hygined	1.12	0.889677
educa2	1.12	0.891442
Mean VIF	1.35	

Source: Own computation from REST survey 2010/2011